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JOURNAL OF CHEMICAL EDUCATION

for June, 1938

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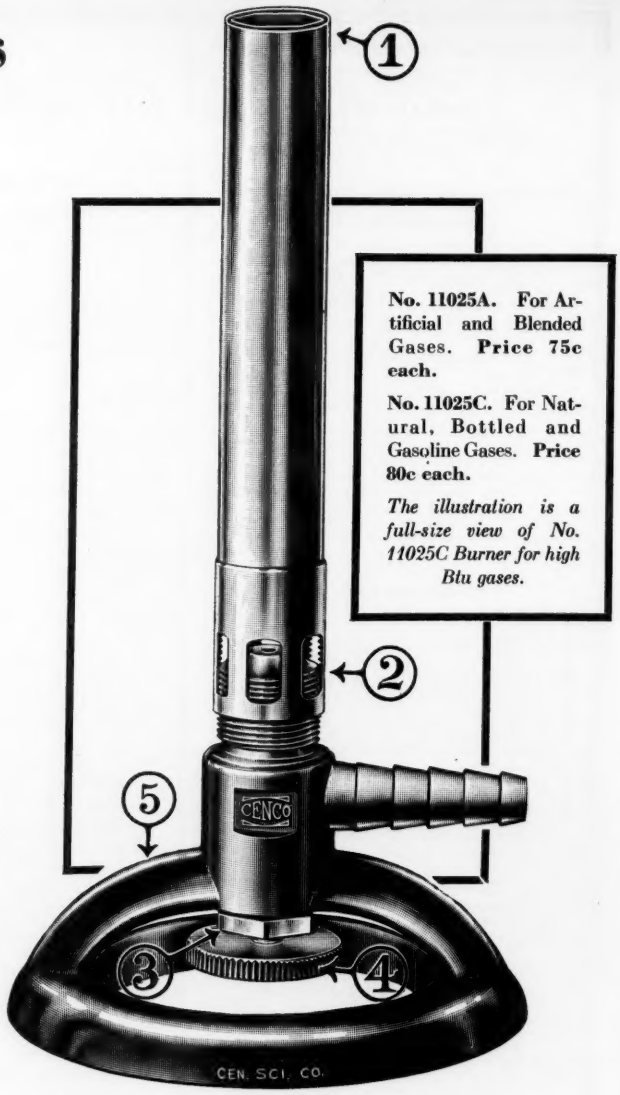

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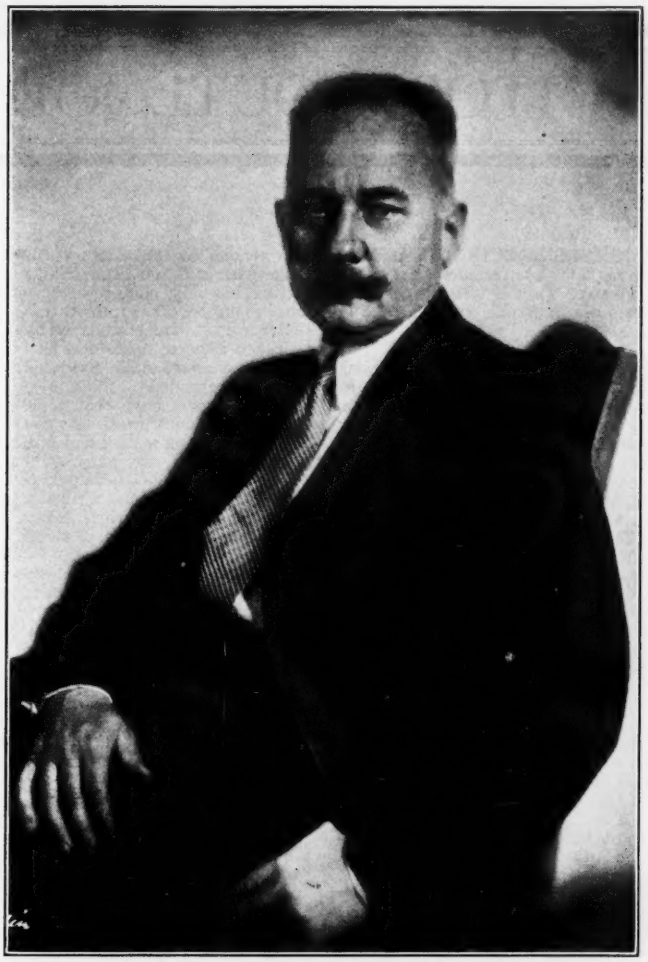


MAX BODENSTEIN (1871–)

Max Bodenstein, one of the foremost physical chemists of his generation, was born at Magdeburg on July 15, 1871. He received his chemical training principally at Heidelberg (Ph.D., 1893). Assistant to Ostwald at Leipsic (1900–06), extraordinary professor at Berlin (1906–08), professor at Hannover (1908–23), in 1923 he succeeded Nernst as director of the Physical Chemical Institute of the University of Berlin. He became director emeritus in 1936. Dr. Bodenstein was visiting professor at Johns Hopkins in 1929, and holds an honorary Sc.D. from Princeton.

In 1892, he applied to Viktor Meyer for a doctorate topic and hoped that he would be allowed to synthesize new, beautifully colored, well-crystallized compounds. Great was his disappointment when, instead, Meyer insisted that he make a study of the thermal decomposition of hydrogen iodide. Neither of them suspected that the whole of Bodenstein's chemical career was then determined, that practically the sole content of this forty years of research would stem from this doctorate research, that he would become the world authority in this field of physical chemistry.

The kinetics of gas reactions, the measurements of reaction velocities, of equilibria, reaction orders, the effect of foreign materials, homogeneous and heterogeneous catalysis, photochemical and reactions in the dark, have occupied him and the numerous co-workers who came to the laboratory to learn the modern methods of investigating these systems.

The mere accumulation of accurate data on a wide variety of cases was followed by intimate examination of these reactions, and the factors which govern their course were disentangled. The rôle of intermediate products received special attention and resulted in the important discovery of chain reactions. In these, activated reactants produce not only stable end-products, but energy-rich intermediates which in turn activate more reactant. For example:

$$Cl_2 + \text{light} = 2Cl^* \text{ (active intermediate I)}$$
$$Cl^* + H_2 = HCl + H^* \text{ (active intermediate II)}$$
$$H^* + Cl_2 = HCl + Cl^* —$$

Most gas reactions were found to be of this type and many anomalies have been satisfactorily elucidated as due to the effects of impurities on the chain. Bodenstein's method of calculating the velocity of such reactions is in general use. The study of numerous photochemical reactions led him to an explanation of the fact that Einstein's Law of Photochemical Equivalence

$$m_1 + h\nu \rightleftharpoons m_2 + m_3$$

does not hold in all cases. An interesting result of his studies was the elucidation of the fact that many gas reactions apparently will not proceed unless there are present at least traces of water vapor. All the known cases were found to be chain reactions, and it was discovered that intensive drying of the gases always introduced impurities which, even in traces, prematurely broke the chain and thus cut down the velocity of the reaction to the point where it apparently had not occurred.

Among those who have worked in Bodenstein's laboratory are C. G. Finck of Columbia, S. C. Lind of Minnesota, G. Kistiakowski of Harvard, and H. S. Taylor of Princeton.

(*Contributed by Ralph E. Oesper, University of Cincinnati*)

EDITOR'S OUTLOOK

AN INVITATION TO TEACHERS OF SCIENCE. *Editor's Note: This notice was received too late to be included in the body of the present number of the* JOURNAL. *In view of its importance, and of the desirability of prompt publication, this page is devoted to it.*

The American Association for the Advancement of Science has established a Committee on the Improvement of Science in General Education which it is hoped will serve as an agency whereby professional scientists and teachers may coördinate their efforts to provide a better educational service. The preliminary announcement of this committee appeared in *Science* for May 20th. The executive committee is issuing an invitation to teachers and professional scientists, departments, and interested groups to coöperate with it in submitting their views on the major questions with which the Committee is concerned.

Though the schools and colleges have done excellent work in training professional scientists, they have succeeded less well in making the general public scientifically minded and in bringing it to understand how science could contribute much more to social well-being than it does at present. The scientist himself is well aware that society derives much less from the discoveries of science than it might. Though the more salable discoveries of science are usually taken up with remarkable speed, others that might be of even greater benefit to society are neglected because they are of a less commercial character. In private, at least, the scientist often expresses his disappointment that men in positions of authority do not adopt a more scientific and impersonal attitude in approaching social problems. Often, too, he is distressed to know that his budgets are the first to suffer when expenses have to be cut.

Science, moreover, has played an outstanding rôle in transforming men's environment and the conditions of their living. It has not, however, touched many of the underlying beliefs that were developed in an earlier phase of social development and many of which have been rendered obsolete by the advance of science. The survival of these beliefs prevents people from adjusting themselves effectively to the conditions of contemporary society and from contributing as they should to the direction of public affairs. It also results in unhappy conflicts between individuals and also within the individual.

An increasing number of non-scientists are becoming aware of these conflicts that have arisen with the advances of the sciences, though they are reacting to it in very different ways. Some believe that the conflicts can be reduced only by slowing down the scientific advances. Others believe that the best course would be a further encouragement of the sciences and especially of science teaching. Others believe that the conflict can only be solved by quite other methods. It is with the second of these views that the present committee identifies itself.

There are some colleges in which science is taught in ways that serve the wider social aims that we have indicated. In many schools it is taught in a formal way, quite unrelated to the rest of the educational program, and fails to arouse any vivid interest in young people. In this it is charting for itself a fate similar to that which overtook the classics. Many science courses have been planned with primary regard for the man who is "going ahead" with the subject and the non-professional student has had to get what he could out of the courses. In many subjects the teachers are prevented from reforming their methods by pressure from their colleagues in the higher branches of education to whom students will go later on. This is particularly true of those subjects in which professional interests can at present write their own tickets in introductory courses. Too often there is no spokesman and too little consideration for the victim who is getting his only glimpse of science in such courses and who must go on thereafter into other kinds of work. Yet he will have to live in a world largely shaped by the influence of science; he may be called upon to make decisions involving scientific knowledge and is at a considerable disadvantage by lack of familiarity with scientific methods.

Happily there have been some efforts to right this situation through the development of survey courses, general courses, and also pacts among science departments. These are still in the experimental stage, and many of them are damned at the outset by a lack of confidence on the part of the scientists who see in them another futile search for a royal road. Sincere as these reactions usually are, it is a curious contradiction, typical of the present situation, that scientists, of all men, should hesitate to give such experiments a fair trial.

As matters stand, we need very much to know a number of things about what is being done to provide courses that are aimed at the kind of science teaching which will serve the interests of general education. The committee therefore invites replies to the following questions:

(1) What are the specific aims of the professor in charge of any general course in a science in his college?

(2) To what extent are his procedures guided by these specific aims, and to what extent by other considerations?

(3) How close does he come to achieving his aims; what happens to his students as a result of their following his course?

(4) Are the courses which are planned to cater for the non-specialist really ineffective for the training of future professionals?

After obtaining replies to these questions, the Committee proposes to consider the further problem of improving present teaching procedures. For the benefit of scientists who have been preoccupied in their own fields of investigation, it may not be amiss to say that some progress has been made in measuring the extent to which the aims of a given educational program are being achieved. In a recent study, for example, it was found that

(*a*) Many teachers find considerable difficulty in formulating their aims.

(*b*) There is a great diversity of aims as stated by those who teach general courses in the same subject.

(*c*) Once the aims of any particular course are stated clearly, it is quite possible to make some measure of the degree to which they are being achieved.

(*d*) Such inquiry results in measurable improvement in science teaching. This improvement does not come from the discovery of any panacea, but from giving the teacher a better perspective of his work and the means of doing something about it.

Through a broad inquiry into the aims and methods of science in general education it should be possible to discover what measure of common agreement there is between people who have given their minds to the problem and to devise programs of general education which will be effective in realizing them.

In view of the importance of this task it is hoped that all who can contribute to its work will give the committee the benefit of their experience. A prompt and thoroughgoing reply to a preliminary inquiry now in the hands of a large proportion of Science Teachers at college and university level in the United States will enable the committee to utilize the summer months to good effect in its first study. A letter to the Chairman of the committee, Lloyd W. Taylor, Oberlin College, Oberlin, Ohio, from any who do not happen to have received the preliminary inquiry, will open the channel for the contribution.

The "BANQUET DES CHIMISTES," PARIS, APRIL 22, 1867

C. A. BROWNE

Bureau of Chemistry and Soils, U. S. Department of Agriculture, Washington, D. C.

[In the January, 1938, issue of Nouvelles de la Chimie *is a notice of the presentation of a piece of rare memorabilia by Dr. Charles L. Parsons to the library of the Maison de la Chimie in Paris with a brief expression of appreciation on the part of French chemists for this act of friendship and generosity. The item consists of a portfolio of the original manuscript toasts and signatures of a group of internationally known chemists who took part in a banquet at Paris on April 22, 1867. A description of this gift, without mention of the donor's name, is given on page 474 of the News Edition of* Industrial and Engineering Chemistry *for November 10, 1937. Since the toasts by Dumas, Playfair, Balard, Liebig, and Hofmann and the letter of Chevreul, prepared for this occasion, must have a wide historic interest, the following translation of their remarks and of the explanatory statements of the Secretary of the Banquet Committee, Dr. L. Grandeau, is submitted herewith.]*

✦ ✦ ✦ ✦ ✦ ✦

THE French chemists gave a banquet, last April 22, to the foreign chemists and physicists who were attending the Universal Exposition in Paris. This brilliant reunion of the illustrious scientists of the two continents was presided over by Senator Dumas, Member of the Institute. Messieurs Fremy and Thenard of the Institute and Monsieur Wurtz, Dean of the Faculty of Medicine, who kindly consented to assume the responsibility of organizing the festivities, performed the honors with a cordiality and courtesy of which each one of those present will always preserve a pleasant remembrance.

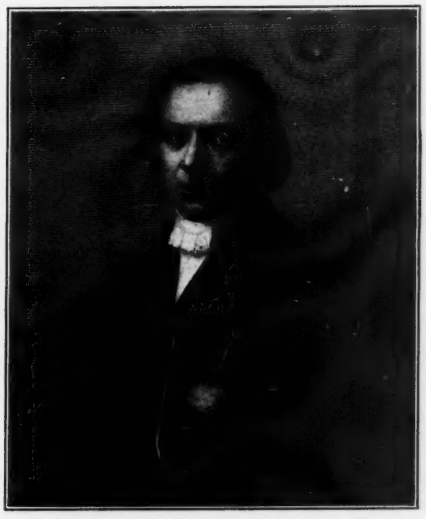
At the close of the banquet Monsieur Dumas rose and proposed the health of the foreign scientists as follows.

TOAST OF PROFESSOR J. B. DUMAS

To the English physicists and chemists in appreciation of their noble and loyal hospitality so often enjoyed and in remembrance of that friendly evening party at Greenwich during the last Universal Exposition.

If it is true that observation guided by analogy and that analogy, verified, controlled and confirmed by experience, have constituted the basis of modern natural philosophy, then let us pay homage to the science of Germany which in 1652 created the first school for cultivating the art of observation—the Academy of those curious about Nature; let us also pay homage to Italy who at Florence in 1657 created the first school for cultivating the art of experimentation—the Academia del Cimento: they are our ancestors!

But let us thank especially England and the Royal Society of London. For two hundred and seven years, with a perseverance and liberality that are truly British, it has gathered knowledge without interruption; it encourages scientific research and glorifies the men who contribute to the progress of the human spirit.



J. B. DUMAS

Other societies, formed in its image, have kept aflame the torch of modern learning in the same way; the Paris Academy of Sciences which it is not becoming for me to eulogize; the Munich Academy, whose illustrious president, Monsieur Liebig, can regard himself, without arrogance, as the hero of these festivities;

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the Academy of Stockholm to which Berzelius has lent so great a lustre; the Academy of Berlin, always so worthily represented among us, which, although having lost Humboldt, Leopold de Buch, Mitscherlich and Rose, seems not to have been impoverished; the Academy of St. Petersburg, which Monsieur Jacobi and the discovery of electrotyping have made so popular in France; the Academy of Vienna to which Monsieur

LYON PLAYFAIR

Schroetter and the discovery of amorphous phosphorus have given exceptional distinction; the Academy of Geneva whose de la Rives, de Candolles, Prevosts, Pictets, and de Saussures prove that the nobility of science is inherited the same as that of blood; the Academies of Brussels, Madrid, and their numerous sisters of the old and new world, whose eminent representatives we have with us, give to this reunion the double character of international and universal.

They all contribute by their works to the progress of the sciences; they can, since the spirit which animates them is the same, exchange their personnels and, to employ the language of chemistry, practise with another substitution without their stability suffering in the least. But between them there is no question of rivalries, or of exchanges, or of substitutions. No! All the Academies of the civilized world make only one. For science the distinctions of nationality disappear. There is only one flag!

Everywhere its mission is the same: to throw light upon the varied aspects of nature. On the one hand to clarify the operations of the arts and the common acts of life, supplying the former with exact apparatus and with quick and perfect processes; prescribing for the latter rules for a well-considered and beneficial hygiene. On the other hand to study the conditions of equilibrium in the universe, its laws, the interdependence of its parts, the relations that unite them in time and space; to define inanimate and animate matter, rest, and motion, forces; thus revealing to the modern world an order, harmonies, splendors, of which the ancient world had no suspicion.

Yes, the Academies, which are scattered over the surface of the globe, make only one. They march before the nations like a beacon which guides them through errors and obscurities to the knowledge of natural truths; reminding us, if that comparison be permitted, of that column of fire which led the Hebrews through the desert to the promised land.

In England the torch of science has had for its supports during two centuries, Newton, Watt, Cavendish, Priestley, Dalton, Wollaston, Davy, Faraday. Six or seven generations have scarcely passed and already they represent mathematical genius in its most glorious expression, practice in its highest development, the inventive spirit under its most productive forms. Newton has brought the orbits of the stars under the control of calculation; Watt, the land and seas under the control of steam; Dalton has given to chemical philosophy the atomic theory, its last formula; Davy has revealed to practical chemistry a universal agent of decomposition—the voltaic pile; and electricity in the hands of Faraday has become a docile and tractable force.

Happy nation where such geniuses succeed each other without interruption and without break! May it long prosper!

To the memory of these great men! Long life to Faraday! May he long enjoy his great renown! To you all here present, their worthy successors, their brilliant emulators, English physicists and chemists, cordial greeting and loyal friendship!

+ + + + + +

Monsieur Lyon Playfair replied as follows to the brilliant impromptu remarks of Monsieur Dumas.

TOAST OF DR. LYON PLAYFAIR*

In the Memory of the Exhibition of 1862 there is nothing so lively in the minds of English Chemists as that dinner at Greenwich, where we were honored by the presence of so many illustrious French Chemists, whose personal acquaintance some of us then made for the first time, though their names had been household words among us, and although their works had long been our admiration and excited an ardent but generous desire of emulation.

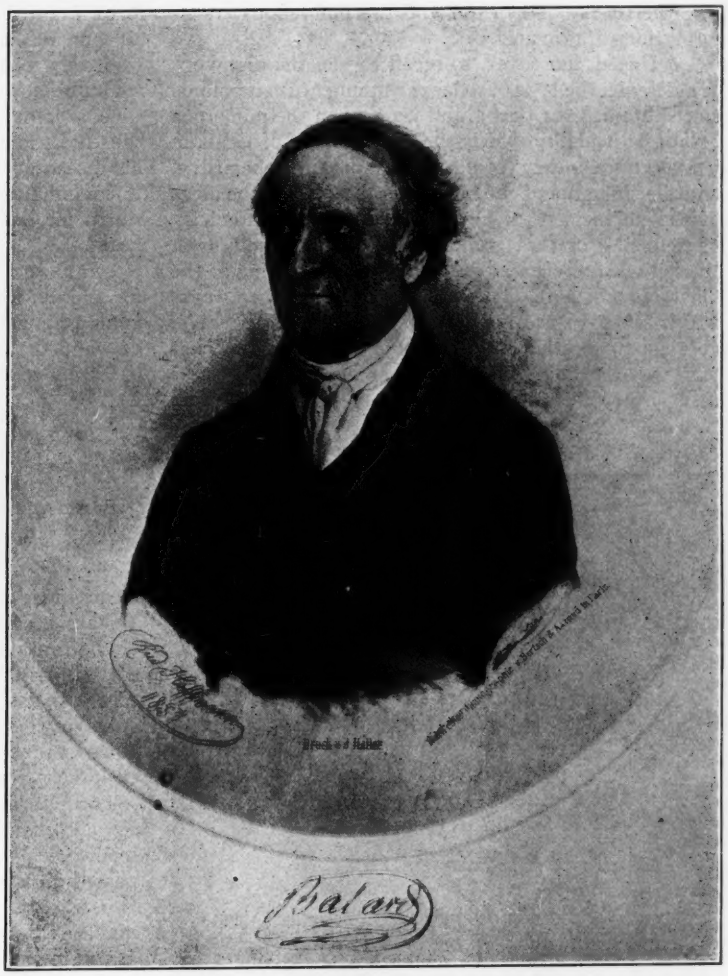
The Exhibition of 1867 will also chiefly live in our

* Transcript of the original English text of the toast in Playfair's handwriting.

memory by the fraternal return and cordial reception which the physicists and chemists of France have accorded to us in their great Capital—a City renowned in the history of the world and dear to our hearts as the scene of the labors of Lavoisier, Dulong, Gay-Lussac and Thénard, as well as those eminent Savants who adorn France at the present day and who have extended their hospitality to us on the present occasion.

Sir, permit me in the name of the English chemists to return you our warmest thanks for your munificent reception. To us nothing could be more gratifying than to have as the President of this banquet a philosopher, who has won such renown in abstract science, and yet who was the first among us by his great work "Chimie appliquée aux Arts" to show that pure science should be directed by special channels into the fields of industry, in order to irrigate and fertilize them by its overflowings. In the year of a great International Exhibition, you are a worthy representative of the fact that the comforts and resources of mankind have been greatly augmented by the sciences which we cultivate for the love of truth and which we are glad to see applied so largely to the advancement of industry.

Again, Sir, I thank you in the name of my colleagues and convey to you their sentiments of warm appreciation for your kindness and hospitality and of our affectionate regards for our scientific brethren in France.



A. J. BALARD

✦ ✦ ✦ ✦ ✦ ✦ ✦

Monsieur Balard then took the floor and proposed the following toast to the health of the famous chemist of Munich.

TOAST OF PROFESSOR A. J. BALARD

Gentlemen:

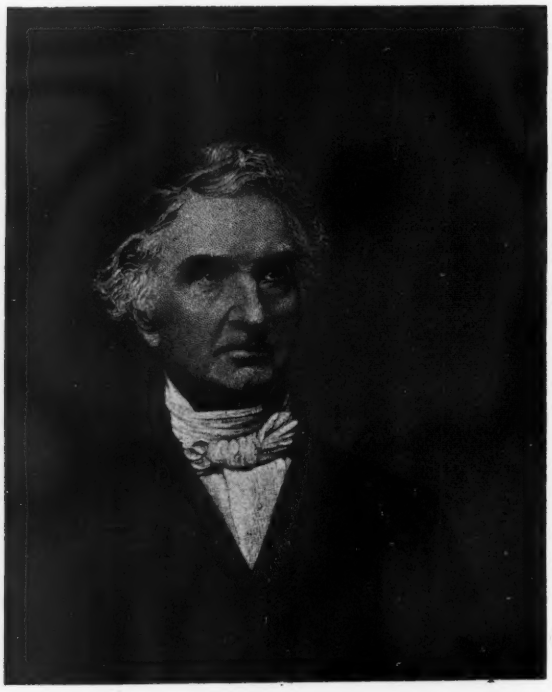
I have the honor to propose a toast to one of our most eminent colleagues, to a famous chemist whose name occurs to each one of us whenever we make an organic analysis.

His name is popular everywhere and especially in the three great countries which by a fruitful emulation have contributed most productively for forty years to the progress of organic chemistry. In Germany, of which it is one of the most noble offspring; in our country which claims it also and to which it appertains by the studies of its youth and by their first researches published under the auspices of Gay-Lussac who was their instructor; in England where heated arguments concerning the influence of mineral compounds upon vegetation have had a salutary effect in promoting the doctrines of our great Lavoisier, of which Davy was also an ardent advocate.

Do I need, gentlemen, to recall to you the titles which recommend him to our most lively sympathies? Who does not know the fruits of the collaboration, so long and so active, of those two eminent chemists, almost always separated, yet always friends, whose names are united in Germany by a glorious community of works just as the names of Gay-Lussac and Thénard are similarly united in France. The Institute in naming these two among its foreign associates has indicated that it does not wish to disunite scientists to whom we

owe the theory of benzoyl and the marvellous transformations of uric acid.

Do I need, moreover, to recall to you the discovery of aldehyde, the type of so large a number of compounds since obtained? or that grand work upon the numerous polybasic acids by which the fruitful idea of Graham has been definitely confirmed in organic chemistry, and the thoughts of chemists later directed to the ideas of the polyacidity of alcohols and the polyatomicity of elements? or that grand and fruitful memoir upon the flesh of muscle and the remarkable resolving of the alkaloids which it contains? or so many other works which occur to the memory of each one of us? No, gentlemen, for the chemist whom we honor here has made more than excellent researches, he has made men; everywhere he has made them spring up around



JUSTUS VON LIEBIG

him. He has created in Germany, from which they have emanated everywhere, those great laboratories to which young students rush from all parts of the world, not so much to learn chemistry as to make it advance; gathering inspiration not only, as formerly, from the word of the master but also from that of their numerous fellow disciples; corrected, clarified, and inflamed by the mistakes, the sagacity, and the zeal of their emulators. Thanks to such a conclave, the little town of Giessen has become a flaming intellectual hearth in Germany and from its modest source has gone forth a crowd of chemists who are numbered today in all countries among the most respected masters—they who only yesterday were pupils of the eminent man whom we now honor.

Gentlemen, everything in his life has served the cause of scientific progress; his lessons, his examples, his incessant activity, all of which he has known how to communicate to those around him, even his polemic spirit, fervent yet tempered by his great kindness of heart.

I propose a toast to the man who has done so much for science, who mingles with us here in fraternal companionship and, in his person, to our German colleagues of whom he is the most distinguished representative.

I drink to the health of Monsieur Liebig.

✦ ✦ ✦ ✦ ✦ ✦ ✦

Baron von Liebig then replied as follows.

TOAST OF PROFESSOR JUSTUS VON LIEBIG

Gentlemen:

I am keenly touched and most deeply appreciative of the sentiments which my honorable confrère, Monsieur Balard, has just expressed to me. I beg him to accept the sincere assurance of my gratitude.

Having been called in my turn to give a toast, I am going to propose to you one which I am sure will obtain the approval of you all.

I propose a toast to the memory of two of the greatest French chemists, of two of the founders of modern science, whose admirable works have never been surpassed and which will always remain our models; of two scientists who, as men, represent the highest qualities of the French nation; you already know that I wish to speak of Gay-Lussac and Thénard.

You are all familiar, gentlemen, with the great discoveries which we owe to the common efforts of these two men who were bound together in close friendship and whose works had their origin in these same friendly ties.

You know why their names are forever inseparable in the history of science. You are familiar, gentlemen, with the merits of Gay-Lussac and Thénard, but there are few among us who have had the good fortune of knowing these scientists personally. The need of paying them my tribute of remembrance causes me to relate to you a few words of reminiscence.

What these two men did for me will suffice to make you understand what they have done also for many others.

I arrived in Paris, forty-four years ago, a young student, a lad of nineteen, without any other recommendation than that of my desire for instruction.

I had brought to Paris the manuscript of a little work on the fulminates of silver and mercury, which I requested Monsieur Thénard to present before the Academy.

Thénard, who was then president of the Academy, received the young foreign student with the greatest kindness. The note was read by Gay-Lussac and the report upon it was made by Dulong.

From that time I possessed in Paris the warmest friends. Monsieur Thénard procured for me a laboratory where I could pursue my works and I was overwhelmed with happiness when Monsieur Gay-Lussac received me in his home, opened to me his laboratory of the Arsenal, and offered to assist me in finishing my work upon fulminating silver and mercury. It was that which gave direction to all my later works.

"Monsieur Liebig," he would say to me every day, "you must occupy yourself with organic chemistry; that is what we have need of." I was, I believe, his first pupil. After me came my friend Pelouze, whom a cruel sickness prevents from being with us today.

Never shall I forget the hours passed in the laboratory of Gay-Lussac. When we had finished a successful analysis (you know without my telling you that the method and the apparatus described in our common memoir were entirely his); when we had finished a successful analysis, he would say to me, "Now you must dance with me just as Thénard and I always danced together when we had discovered something new." And then we would dance.

Gentlemen, you have often heard Thénard called "Father Thénard": He was truly our father; the father of us all, who had for everyone a helpful hand which he never refused to the weaker ones in order to help them climb the ladder and overcome difficulties.

Monsieur Dumas could also tell you something about him, for he was his favorite; and he was so rightly—the favorite pupil of Thénard. Upon that point it is not possible to have two opinions. He was the first; he has remained the first.

Therefore, gentlemen, to the memory of Gay-Lussac and Thénard, the founders of our modern science, the representatives of the highest qualities of French character.

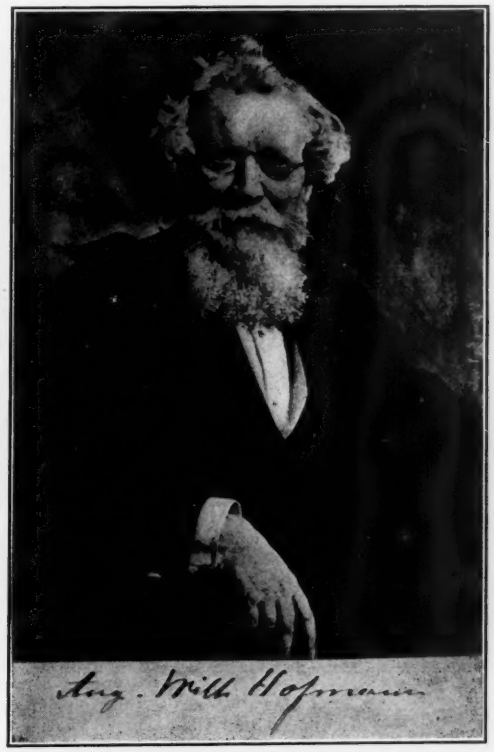
✦ ✦ ✦ ✦ ✦ ✦

Monsieur Liebig was followed by Monsieur Hofmann, the eminent professor at Berlin. He spoke as follows.

TOAST OF PROFESSOR A. W. HOFMANN

After the eloquent discourse of our illustrious president; after the no less eloquent response by the distinguished chemist from Scotland; after the cordial toast of the celebrated scientist of the College de France; after the reminiscences, so glorious and touching, related by my master, by my dearly beloved master, it is only with extreme diffidence that I ask your permission to speak a word. I am persuaded, however, that the sentiment which moves me will not fail in finding a responsive echo in your hearts.

In an assembly which represents the intelligence of two hemispheres, the human spirit is extended and subdivided into an infinity of ramifications. But all these ramifications converge and reunite into two great parallel streams—the one that of pure science, or *theory;* the other that of applied science or *practice.* These two great streams very often approach each other and even intermingle, the one sustaining and strenghthening the other. Although the task is a most attractive one, I shall not undertake, gentlemen, to picture here, either



A. W. HOFMANN

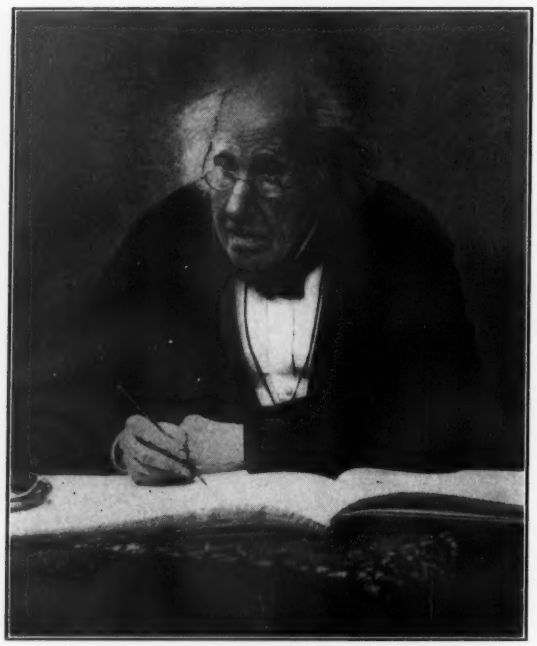
the numerous services rendered by science to industry or the promptness with which industry has hastened to repay its debt of gratitude. It is in fact to this alliance, one and indivisible, between science and industry and to the benefits which it lavishes upon humanity that we owe this reunion, brilliant and memorable for all time.

If I am permitted, however, to fix your attention for a moment upon these two great levers of human progress, science and industry, it is because France has the good fortune, at once rare and remarkable, of possessing a man whose universal genius and imperishable works have exercised a powerful influence upon both the one and the other. Is it necessary, gentlemen, to mention the name of this man? I read in your eyes that his name is upon your lips, and I know that I

awaken a deep and sympathetic feeling in your hearts in proposing that you join me in offering a toast to the health of Monsieur Chevreul, at once the founder of a new science and of a new industry.

May heaven protect that precious life and grant to the venerable dean of science for a long time to come that youthful freshness which makes him at once the joy of his friends and the admiration of the world.

Gentlemen, I ask you to fill your glasses to the brim, to fill them with that delicious product of the soil of France, and drink with me to the health of Monsieur Chevreul.



Courtesy of Pix Publishing, Inc.
MICHEL-EUGENE CHEVREUL

✦ ✦ ✦ ✦ ✦ ✦

After these toasts, which were each received by the assemblage with the liveliest sympathy and warmest applause, Monsieur Dumas read the following letter which was addressed to him, the day before, by the dean of chemists, the illustrious professor of the Museum and of the Gobelins.

Paris, April 21, 1867

Monsieur and Dear Confrère:

In expressing my regrets for not replying to the invitation to attend a reunion in which it would have been so great a pleasure for me to take part, please accept my appreciation for the generous feelings which prompted your letter and at the same time kindly consent to act as my spokesman to those whom love of science will reunite tomorrow at the same table. I would be happy if, in speaking of my deep annoyance at having lost the opportunity of grasping the hands of so many young scientists whose persons, alas, I shall never see, you should tell them that I will continue, none the less, to follow their labors with the most lively interest. It is a great satisfaction for one, who has had the good fortune to know men like Berthollet, Proust, Vauquelin, Gay-Lussac, Davy, and Berzelius, to realize that they will have worthy successors.

The association with people who are present with us, the sentiments of international fraternity, uniting together but without weakening the feeling of patriotism which each one owes to his own country, are great grounds of hope, for the friend of science as well as for the friend of humanity, in thinking that a happily inevitable consequence of this rendezvous of nations at the home of one of them will be to bind closer and closer together the sentiments of all civilized people.

And while awaiting the full realization of that hope, declare very loudly, my dear confrère, in the name of the absent one, how happy he is to think of the great influence which the sciences, that are so happily represented in this reunion, have already had in lowering the barriers which separate peoples and that he has faith in the happy influence which they shall not cease to exercise for the happiness of all the individuals that make up a civilized people!

Will you propose, dear confrère, in my name the following toast: Health, prosperity, and success to all friends of the sciences who are here present and also to the absent ones who would deserve to be here.

Accept, dear confrère, the expression of my feelings of deep gratitude.

E. CHEVREUL

The reading of this letter was received with hearty applause. The recollections of this reunion, at once so brilliant and so cordial, will remain inscribed upon the memories of all; giving to some, the illustrious deans of contemporaneous science, a new mark of the respect which is accorded to them by the succeeding generation; recalling to others, the young scientists on the entrance of their careers, the sympathy and affection of those who have opened for them the way; and showing to all that the distinctions of nationality, of age, and of rank are obliterated before the noble flag of science, carried so high today in the two hemispheres.

DR. L. GRANDEAU

May 25th, 1867

✦ ✦ ✦ ✦ ✦ ✦

The manifestation of international good will and of the universal brotherhood of science, so feelingly expressed at this banquet of chemists at Paris in 1867, make us feel in this present day of intense nationalistic glorification that the world has relinquished the high ideals that were announced by the great leaders of chemistry seventy years ago.

Almost equal in interest to the manuscripts of the toasts which were offered at this banquet is the register of the one hundred eight attending chemists. There are inscribed here in addition to the speakers at the banquet the names of such celebrities as Becquerel, Berthelot, Boussingault, Cahours, de la Rive, Dubrunfaut, Fehling, Foucault, Frankland, Friedel, Kane, Kekulé, Ladenburg, Magnus, Peligot, Pelouze, Regnault, Richter, Roscoe, Sainte-Claire Deville, Schrötter, Siemens, Sterry Hunt (the only American representative), Tyndall, Varentrapp, Wanklyn, Wheat-

stone, Widermann, and Wurtz, names which have become almost household words to every student of chemistry.

In the eloquence of its addresses, in the renown of its representatives and in the cordial expressions of its fraternal spirit, the Banquet des Chimistes at Paris in 1867 set a standard which has probably never since been equaled.

WHAT IS "CULTURAL" CHEMISTRY?

GLEN WAKEHAM

University of Colorado, Boulder, Colorado

"CULTURE" is the "training, improvement, and refining of the mind, morals, or taste; enlightenment."[1]

Chemistry is a body of scientific theory based upon a large accumulation of observed fact.

The impact of chemistry upon morals and taste will be slight; hence we may consider the "cultural" effect of chemistry with regard only to mind and enlightenment.

Chemistry is taught at three fairly distinct levels:

1. Descriptions of chemistry. This consists of recounting the applications of chemistry, emphasizing its wide usefulness, and prognosticating its probable future triumphs. It is not really chemistry at all, but merely talk about chemistry; and therefore should not be called chemistry.

2. Empirical chemistry. This includes the study of actual chemical facts, along with didactic statements of laws and theories, with little or no attempt to explain the philosophical basis of the theories of the science. "Dalton said, 'Let there be atoms,' and there were atoms." Traditional elementary chemistry teaching has been chiefly at this level.

3. Theoretical, or philosophical, chemistry. Little by little it is coming to be realized that cultural "enlightenment" involves the comprehension, or understanding, of phenomena, or at least of the theories by means of which we attempt to explain phenomena. This should be the "crowning glory" of any chemistry course, and the "crowning joy" of any teacher who can "explain" chemical theory effectively should be the glow of intelligent satisfaction on the face of the student who finally "understands."

To what extent do high-school chemistry teachers realize these facts? A recent examination of the "objectives" of the high-school chemistry teachers of a large state,[2] as stated by the teachers themselves, reveals the fact that most of these teachers draw a sharp line of demarcation between "cultural" and "college-preparatory" topics. "Cultural" chemistry, in the minds of these teachers, consists almost entirely of descriptive and empirical topics, with a very slight smattering of purely didactic theoretical presentation. The theories of chemistry are nearly all relegated to the "college-preparatory" group. This, of course, is an exact inversion of the facts. An intelligent comprehension of the philosophy of chemistry constitutes the highest, most enlightening degree of culture obtainable from a study of the science, while the majority of college chemistry teachers would prefer to have high-school graduates come to them with a sound knowledge of simple, empirical chemistry rather than a hazy, purely verbalistic memory of definitions, laws, and principles.

The student mind works, roughly, at two fairly distinct levels—pure memory, and intelligent comprehension. It is doubtful whether pedagogic method can increase, develop, or induce either of these aspects of intellectual activity to any appreciable degree. About the most the teacher can hope to do is to coax the student to devote a part of his mental capacity to systematic, useful learning, along with the casual, chaotic, but unavoidable accumulation of impressions from movies, magazines, newspapers, and social—or anti-social—contacts. If the student can be induced to build up a fair foundation of factual knowledge, there is always the hope—too often disappointed—that he will manifest sufficient intuitive faculty to enable him to gain some comprehension of the philosophy of science. He cannot be expected to understand what he does not know.

Three courses of action, in general, are open to the elementary chemistry teacher, depending upon the type of student with which he has to contend. If the average student in his classes is unable—or unwilling—to learn the facts of chemistry, he can be treated to a more or less exciting and romantic description of the uses and applications of chemistry. This, however, should not be called chemistry, but "descriptive

[1] "Comprehensive standard dictionary," Funk & Wagnalls, New York City, 1937.

[2] HARMS, MARGUERITE, "Cultural, vocational, and college-preparatory factors in the teaching of chemistry in the high schools of Louisiana" (unpublished thesis, University of Colorado).

science," or some such term. There is probably a place, in the upper high-school grades, for such a descriptive course, including chemistry, physics, and some simple mathematical applications, on a somewhat higher level than eighth or ninth grade "general science." Some city universities and junior colleges are giving, with considerable success, a course of this type, in which physics and chemistry are taught as complementary to each other, the necessary mathematics being introduced as required. In the high school, such a course might be regarded as "cultural," at a fairly high level.

Most elementary chemistry teachers seem to have chosen—or to have been forced by circumstance—to teach chiefly empirical chemical knowledge, seasoned with a little history, descriptions of spectacular chemical phenomena, factory visits, and occasional polite gestures toward chemical philosophy. If they can by this policy entice their students to learn a little "real" chemistry, they are probably making the best of a bad situation, having to deal, as they do, for the most part, with students who have no adequate background in the essential common branches. But they should not deceive themselves into thinking that what they are teaching has any "cultural" value, save at a rather low level. And they should be on the look-out for the occasional student who has the capacity for comprehending the science of chemistry, giving him every possibility to cultivate his intelligence.

There are a few elementary chemistry teachers who feel that they are able to teach chemistry in a genuinely cultural way. Usually they are fortunately situated, with regard to the average intelligence of their students, the encouragement of liberal school authorities, and the support of intelligent, cultured parents. But the successful presentation of such a course requires a degree of technical training, energy, enthusiasm, personality, and pertinacity which is rare among chemistry teachers. It is a pleasure and an inspiration to meet, in college classes, the pupils of such teachers. If we only had more of them!

The chief object of this paper is to protest against the widely accepted notion (held by elementary chemistry teachers, school authorities, and even college presidents) that "cultural" chemistry consists chiefly of talk *about* chemistry rather than the attempt to lead the student to a comprehension of the underlying philosophy of chemistry. The idea that theoretical chemistry should be relegated to special courses designed for students who intend to "major" in chemistry and become professional chemists is essentially vicious. If culture, at its highest level, means "enlightenment," a truly "cultural" chemistry course should aim at giving the student the best possible opportunity to comprehend the essential meaning of that magnificent body of theory which has made chemistry the indispensable servant of almost all the other sciences and arts, and is the foundation of the amazing and all but incredible triumphs of applied chemistry during the past century.

What steps should be taken, or attempted, under the complex and often conflicting circumstances of our educational system to meet the praiseworthy ideal of the "greatest good for the greatest number?" It must be admitted, at the outset, that a large proportion—usually a majority—of the students who present themselves for elementary chemistry will be inherently incapable of comprehending theoretical chemistry in any adequate way, even in its simplest form. The first step lies in the realm of school administration. School superintendents and principals should endeavor to obtain the services of teachers with as high a degree as possible of technical equipment, enthusiasm, personality, and general culture. They should then give these teachers a free hand in the selection of subject matter without inflicting upon them prescribed texts, curricula, or other arbitrary limitations.

Having obtained and accepted this responsibility, the competent teacher should rise enthusiastically and energetically to his opportunity. He should examine carefully the situation in which he finds himself with regard to the economic, industrial, and social factors of his environment, and attempt to diagnose the average capacity of his class. He should then plan a course specifically adapted to the circumstances, including factual chemistry, general applications of the science, and local illustrations. If he discovers that any reasonable proportion of his class seems likely to be able to follow him into the higher cultural realm of chemical theory, he will choose those items of factual material which lead most clearly and directly into chemical philosophy. He will always be on the lookout for the neatest, most effective illustrations and demonstrations. He will become an expert in devising arithmetically simple illustrative problems: for nothing more quickly throws the student off the track of real comprehension than getting tangled up in complicated calculations. Many of the illustrative problems in modern texts function more often as stumbling blocks than as helps in understanding. The competent teacher will look for or devise tests and measurements which will betray genuine comprehension—or the lack thereof—of chemical theory, rather than a mere parrot-like regurgitation of the words of the text.

The most common fault of the enthusiastic teacher is to try to teach too much: but even this is better than a supine surrender to apparently hopeless conditions. If, after a careful study of the conditions in which he finds himself, and a trying-out of the most effective teaching methods he can discover, he is convinced that the bulk of his students are not capable of profiting from careful presentations of theoretical chemistry, he should give them interesting information about chemistry, along with as much factual chemistry as he can coax them to learn. But he should not deceive himself or his students into thinking that they are learning "cultural" chemistry, or even chemistry.

The HYPOGLYCEMIC ACTIVITY *of* ORGANIC SULFUR COMPOUNDS *and the* RÔLE *of* SULFUR *in* RELATION *to the* ACTIVITY *of* INSULIN

CHARLES E. BRAUN,* MARTHA B. MASON,† AND CONSTANCE L. BROWN

The University of Vermont, Burlington, Vermont

INTRODUCTION

THE isolation of insulin in crystalline form by Abel and his co-workers in 1926 (*1*, *2*) made it possible for the first time to carry out chemical investigations on the hormone in a state of reproducibly uniform purity and gave added stimulus to research workers interested in this field. Various observations (destruction by proteolytic enzymes, positive protein color reactions, precipitation by protein precipitants, denaturation, etc.) soon established that crystalline insulin behaved like a protein. As confirmation of this conclusion, the elementary composition of crystalline insulin was found to resemble that of any typical protein with the notable exception of its high sulfur content of 3.34 per cent. as compared to the usual value of 0.3–2.5 per cent. Furthermore, hydrolytic cleavage of crystalline insulin has yielded only alpha amino acids, nine in number, accounting for practically the whole of the insulin molecule.‡ Of the amino acids comprising the insulin molecule, namely, cystine, tyrosine (*3*), glutamic acid (*4*), leucine, arginine, histidine, lysine (*5*, *6*), phenylalanine and proline (*7*), cystine from the point of view of the physiological activity of the hormone probably holds the position of foremost interest and has been the subject of much investigation.

As was mentioned, the sulfur content of crystalline insulin is abnormally high for a typical protein, and almost from the very beginning of insulin chemistry, before the availability of insulin in crystalline condition, a relationship between the sulfur and the physiological activity of the hormone had been postulated. Despite the fact that even today the exact rôle of the sulfur in relation to the activity of insulin is not completely understood, nevertheless, it has been well established experimentally that a definite connection exists. The recognition that sulfur, as cystine sulfur, is an integral part of the insulin molecule and the repeated observation that any reaction which caused the liberation of sulfide sulfur always was accompanied by a loss of part or all of the physiological activity have been the basis for much research on various types of sulfur-containing organic compounds directed toward the discovery or development of substances which might possess physiological properties identical with or similar to those of insulin. Such synthetic sulfur compounds could perhaps be employed therapeutically as insulin substitutes, and probably would have the added advantage of being active by oral administration.

Any compound which possesses insulin-like properties must not only lower blood sugar (hypoglycemic activity), but also, in addition to causing certain other physiological effects, must increase carbohydrate utilization in a diabetic animal or patient, or in other words, it must be capable of raising the respiratory quotient. The terms hypoglycemic activity and insulin-like activity are not in any sense synonymous. It should be clearly understood that even though a compound might produce a marked lowering of blood sugar it cannot be said to possess insulin-like activity unless it also increases carbohydrate utilization. The mere ability of a substance to cause hypoglycemia does not signify insulin-like properties.

It is the object of this résumé to present some of the later work dealing with the sulfur in insulin, to record the various types of synthetic organic sulfur compounds which have so far been studied for insulin-like behavior, and to evaluate these synthetic efforts in the light of the insulin problem.

THE SULFUR OF INSULIN

In 1923, three years before the isolation of insulin in crystalline condition, Dudley (*8*) had suggested that sulfur was an integral part of the insulin molecule. Abel and his co-workers in 1925 not only confirmed the presence of sulfur in insulin but also demonstrated that at least a part of the sulfur was of a labile variety which could readily be split out as sulfide sulfur by treatment with an alkali as weak as 0.1 *N* sodium carbonate (*1*, *2*, *9*, *10*). The observation that the liberation of either a part or all of the sulfur of insulin was always accom-

* On leave: Now at Department of Chemistry, The Massachusetts Institute of Technology, Cambridge, Massachusetts.

† Present address: Department of Chemistry, Women's College, The University of Delaware, Newark, Delaware.

‡ For a detailed presentation of the chemistry of insulin the reader is referred to the very complete review by JENSEN AND EVANS in *Physiological Reviews*, **14**, 188 (1934).

panied by a decrease or total destruction of the physiological activity of the hormone led Abel and Geiling (*9*) in 1925 to conclude, in confirmation of Dudley's (*8*) suggestion, that "this unstable sulfur is an integral part of the insulin molecule" and to postulate that the labile sulfur is related to the potency.

du Vigneaud (*11*) in 1927 presented data to support his conclusion that the sulfur of insulin probably "is present as the disulfide linkage and that insulin is most likely a derivative of cystine." He suggested also that "the cystine in insulin is linked to the rest of the molecule by a peptide linkage." The actual isolation of cystine from hydrolyzed crystalline insulin in 1928 by du Vigneaud, Jensen, and Wintersteiner (*3*) left no doubt as to the existence of this amino acid in the insulin molecule. However, there still remained the question as to whether or not the cystine sulfur accounted for all of the sulfur of insulin.

The absence of sulfhydryl groups in insulin was established beyond all reasonable doubt by repeated negative nitroprusside tests (*8, 12, 13, 14*), a conclusion further supported by the work of Stern and White (*15*). Thiolhistidine was eliminated as a possible constituent of crystalline insulin by the work of du Vigneaud, Sifferd, and Miller (*16*), and of Jensen and his co-workers (*17*). The unsuccessful efforts of Freudenberg, Dischert, and Eyer (*18*), and of the Jensen group (*17*) to find any evidence for the presence of the methylthiol group in crystalline insulin would seem to exclude the possibility of methionine as a part of the insulin molecule, although Kassell and Brand (*19*) have reported the presence of 0.7 per cent. of methionine in crystalline insulin.

It appears, then, with the exception of the report of Kassell and Brand (*19*), that all of the sulfur in insulin exists in the form of dithio or disulfide linkages present in the residues of the amino acid cystine. If this is true, then crystalline insulin should contain 12.5 ± 0.1 per cent. of cystine on a moisture-free, ash-free basis as calculated from the experimentally determined value of 3.34 ± 0.03 per cent. of sulfur (*20*). Therefore, the quantitative determination of the amount of cystine in crystalline insulin is of considerable significance.

The discrepancies appearing in the literature on the cystine content of insulin (values ranging from eight to fourteen per cent. have been reported) have been eliminated by the work of Miller and du Vigneaud (*20*) who hydrolyzed crystalline insulin completely by heating it at 110–120° for forty-eight hours with a mixture of twenty per cent. hydrochloric acid in fifty per cent. formic acid. They adopted this modification of the method of Gurin and Clarke (*21*) after demonstrating that the original procedure, which employed fifty per cent. formic acid with two equivalents of hydrochloric acid for each equivalent of nitrogen, failed to bring about the hydrolysis of insulin. Estimating the cystine by the method of Sullivan and Hess (*22*), Miller and du Vigneaud found a cystine content of 12.5 ± 0.4 per cent. calculated on a moisture-free, ash-free basis. The excellent agreement between the calculated and determined values for the amount of cystine in crystalline insulin unquestionably gives strong support to the suggestion that all of the sulfur in insulin is present as cystine and therefore exists in the disulfide form, the report of Kassell and Brand (*19*) notwithstanding. (Miller and du Vigneaud (*20*) in an addendum to their paper state regarding the observation of Kassell and Brand that "Such a trace (0.7 per cent. methionine) may or may not be present so far as our experimental data obtained with the Sullivan method are concerned.") It certainly is difficult to reconcile the report of Kassell and Brand (*19*) with the work of Freudenberg, Dischert, and Eyer (*18*) and of Jensen and his co-workers (*17*) who were unable to detect the presence of methionine in crystalline insulin, and especially, with the quantitative values for cystine determined by Miller and du Vigneaud (*20*).

It has already been mentioned that some relationship appeared to exist between the sulfur content and the physiological activity of insulin from the fact that when part or all of the labile sulfur of insulin is split out, the activity is markedly decreased or lost completely. Jensen, Evans, Pennington, and Schock (*17*) in 1936, after studying the action of various reagents on insulin, found that the inactivation of insulin was always accompanied by a change in either the cystine or the amino nitrogen content and suggested that the hypoglycemic property of insulin is associated with certain dithio linkages and certain free primary amino groups.* Stern and White (*15*) postulated that all of the sulfur in insulin is present as disulfide groupings and that one or two of these linkages might possess a special function in insulin activity.

In brief, many pieces of experimental evidence clearly point out that the physiological activity of insulin is in some manner connected with the disulfide groups in the molecule. Regarding this point, it seems advisable to give special consideration to the ideas of du Vigneaud, Fitch, Pekarek, and Lockwood (*24*) who studied the inactivation of crystalline insulin by cysteine and glutathione. They concluded that "the disulfide linkage, *per se*, is, however, surely not responsible for the insulin action. This work does not preclude there being present, however, a particular arrangement of the disulfide within the molecule responsible for the activity. What we wish to submit is that more than merely a disulfide grouping is necessary to the action but that the disulfide is, nevertheless, necessary to this action." Furthermore, it is significant that although Blatherwick (*14*) and Freudenberg (*18*) and their co-workers were able to inactivate insulin without affecting the disulfide linkage, nevertheless, up to the present time no one has been able to split out or change the disulfide linkage of insulin without destroying the potency. In view of the recognized significance of the dithio

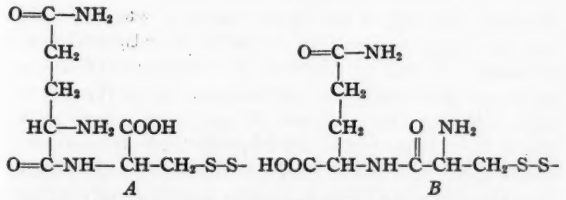
* Freudenberg and Eyer (*23*) do not believe that any connection exists between free amino nitrogen and insulin activity. Very recently Stern and White (*55*), after acetylating insulin with ketene, concluded that tyrosine hydroxyl groups are essential for the physiological activity of insulin but that free amino groups are not.

groups in insulin activity, it was to be expected, therefore, that organic sulfur compounds (especially those related to cystine) should be investigated for hypoglycemic properties, and a number of such compounds have been prepared and studied, some selected systematically and others chosen more or less at random.

CYSTINE AND CYSTINYL PEPTIDES

Cystine itself has received some attention from the point of view of possible hypoglycemic properties. Kon and Funk (*25*) in 1926, after physiological investigation of several compounds of known structure (including cystine and cysteine hydrochlorides) concluded that basic substances tended to lower blood sugar while acidic compounds exerted an opposite effect, and suggested that the hypoglycemic activity of insulin might be due to the presence of cystine and histidine. In 1935, Campanacci and Pezzarossa (*26*) studied the effect of intramuscular injections of cystine in phlorizin glucosuria and found it to be more effective than inorganic sulfur in reducing the glucosuria, which, however, never entirely disappeared. From this observation, coupled with the fact that the blood sugar showed a drop, these investigators also suggested that the physiological behavior of cystine in these experiments was similar to that of insulin but much weaker.

Taking into consideration all of the facts which had been accumulated regarding the relationship between the physiological activity of insulin and its cystine content, and with some consideration of the similarity of the physiological rôle of insulin with that of glutathione (both being activators of certain metabolic processes), Jensen (*27, 28*) suggested that perhaps some combination of cystine and glutamine might be directly responsible for the unique properties of insulin and proposed the following structures as possible essential groupings in the insulin molecule. Although the presence in crystalline insulin of glutamic acid to the extent of about 21 per cent.* (based on the amide nitrogen of insulin (*4, 6*)) supported this hypothesis, it should be clearly understood that these structures are absolutely hypothetical and are devoid of any experimental support. They were proposed by Jensen only to serve as working models to stimulate further research in the insulin field and they have unquestionably fulfilled their purpose.



A — *α-glutaminylcystine residue*

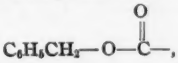
B — *Nα-cystinylglutamine residue*

* Harrington and Mead (*29*) in 1936, from their work on peptides of cystine and glutamine, reported that insulin contains 30 per cent. of glutamic acid based upon experiments on the determination of amide nitrogen and assuming the molecular weight of insulin to be 35,100.

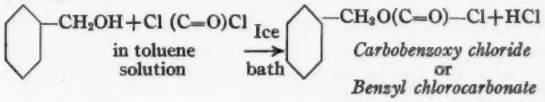
Three supposed essential groupings of the insulin molecule are present in both structures *A* and *B*, namely, peptide linkages, disulfide linkages, and free amino groups. The inactivation of insulin by either proteolytic enzymes or acid hydrolysis probably is caused by cleavage of certain peptide linkages. Allusion has already been made to the fact that irreversible inactivation of insulin is always accompanied by a change in either the cystine or amino nitrogen content (*17*). With Jensen's proposed structures as a guide, it was to be expected that a new impetus should be given for research on the syntheses and study of cystinyl peptides in general with the hope of throwing some additional light on the problem of insulin structure as related to its physiological activity.

Before presenting data on the various cystinyl peptides which have been investigated to date for hypoglycemic properties, it seems desirable to discuss briefly two rather recent developments in peptide synthesis which have proved of almost inestimable value to this particular phase of the attack on the insulin problem. In the preparation of a peptide through the acid chloride of an amino acid it is necessary to protect the amino group of the acid before converting it into the acid chloride. Prior to 1932 a number of so-called blocking groups were available, among them the benzoyl, acetyl, naphthalenesulfonyl, and notably the carbethoxy group. Although they adequately protect an amino group, all of these groups have the serious disadvantage that their removal incurs possible simultaneous rupture of the peptide linkages. Therefore, it had become common practice in peptide synthesis not to attempt to remove such blocking groups. The result was that many of the peptides described in the literature prior to 1932 were composed of amino acid residues in which the amino groups not engaged in forming peptide linkages were blocked. In view of what has already been said regarding the probable significance of free amino groups in the physiological activity of insulin, such peptides containing blocked amino groups could therefore only be of limited value in the synthetic attack on the insulin problem.

In 1932 Bergmann and Zervas (*30*) made a notable advance in peptide synthesis by their discovery of a blocking group which not only could be readily prepared but also could be easily removed from a peptide by catalytic hydrogenation with palladium or platinum black. The new blocking group, the carbobenzoxy radical, is the half benzyl ester of carbonic acid,



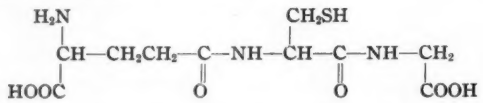
and is introduced into an amino acid or peptide with carbobenzoxychloride (benzyl chlorocarbonate) conveniently prepared by treating benzyl alcohol with phosgene.



During the removal of the carbobenzoxy group by catalytic hydrogenation the benzyl radical is converted into toluene just as in the cases where the simple benzyl group has been employed, as, for example, in benzyl glycosides (*31*).

The catalytic reduction procedure of Bergmann and Zervas was found to give unsatisfactory results with cystinyl peptides, a fact which resulted in the development of new methods for the removal of this blocking group. White (*32*), working on the preparation of cystinyldiglycine and cystinyldialanine, hydrolyzed off the carbobenzoxy groups with concentrated hydrochloric acid at about 60°. Using the proper conditions White was able to take off the protecting groups completely without rupturing the peptide linkages. Harrington and Mead (*33*) introduced a method for removal of the carbobenzoxy group from synthetic peptides by passing dry hydrogen through a glacial acetic acid solution of the peptide and phosphonium iodide. du Vigneaud and Loring (*34*) employed sodium and liquid ammonia for the successful reduction of dicarbobenzoxycystinyldiglycine and of S-benzylcysteinylglycine to produce cysteinylglycine and thereby introduced an excellent method not only for removing carbobenzoxy groups but also a general tool in the synthesis of cystinyl and cysteinyl peptides. Extension of the sodium–liquid ammonia method by du Vigneaud and his co-workers has resulted in the preparation of homocystine (*35*), a new synthesis for glutathione (*36*), the preparation and proof of structure of the newly discovered naturally occurring sulfur-containing amino acid djenkolic acid (*37*), and the synthesis of isoglutathione or α-glutamylcysteinylglycine (*38*).*

The first attempt to produce hypoglycemia by administration of peptides containing sulfur was made in 1926 when Kon and Funk (*25*) reported that they had obtained no hypoglycemic activity with glutathione in either the oxidized or reduced form.

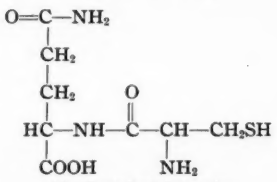


γ-Glutamylcysteinylglycine or Glutathione

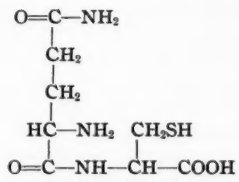
In the same year Brand and Sandberg (*39*) observed that dialanylcystine and dialanylcystine dianhydride injected intravenously showed no insulin-like properties.

In 1932, before the carbobenzoxy blocking group had become available, Harwood and Gilman (*40*) synthesized and investigated the hypoglycemic properties of five peptides of cystine, namely, dicarbethoxycystinyltyrosine ethyl ester, dicarbethoxycystinyltyrosine, dicarbethoxycystinylhistidine methyl ester, bis-(dicarbethoxytyrosyl)cystine diethyl ester and dicarbethoxycystinylarginine. Although the physiological activities of these blocked cystinyl peptides has not been reported, in consideration of what is now known regarding the possible rôle of free amino groups in insulin activity, it is reasonably safe to predict that these peptides in which the amino groups not engaged in forming the peptide linkages were blocked by carbethoxy groups will not possess hypoglycemic properties.

Jensen, Evans, Pennington, and Schock (*17*) in 1936 reported that diglycylcystine, cystinyldiglycine, and γ-diglutamylcystine possessed no hypoglycemic properties. In the same year, Harrington and Mead (*29*), employing to good advantage both the carbobenzoxy blocking group and the sodium–liquid ammonia reduction technic, synthesized the peptides cysteinylglutamine and glutaminylcysteine. These peptides contained the exact structures which had been proposed by Jensen and Evans (*27, 28*) in 1932 as possibly responsible for the hypoglycemic activity of the insulin molecule. Investigation of these peptides in both reduced and oxidized form showed them to be entirely without physiological activity.



Nα-Cysteinylglutamine



α-Glutaminylcysteine

In 1937 White, Lewis, and White (*41*) reported that they had obtained no evidence of insulin shock when glycylcysteic acid, 1-cystinyldiglycine, diglycyl-1-cystine, *d*,1-dialanyl-1-cystine, and 1-cystinyl-*d*,1-alanine were administered in doses equivalent to one gram of cystine per kilo of body weight.

Since in these peptides the unengaged amino groups were free, the lack of hypoglycemic properties certainly cannot be explained on the same basis which might account for the predicted inactivity of the peptides of Harwood and Gilman.

SULFUR-CONTAINING GUANIDINES

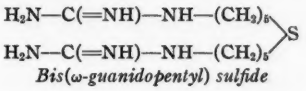
In view of the fact that the guanido amino acid arginine was found to be a part of the insulin molecule, and, since certain guanidine structures were shown to produce lowering of the blood sugar, it was inevitable that guanidine derivatives should be investigated in the numerous efforts to discover a compound of known structure possessing the physiological properties of insulin. While the number of guanidine derivatives which have been tested for hypoglycemic properties is very large, in consideration of the recognized significance of dithio linkages in insulin activity, only sulfur-containing guanidines will be presented here.

Dubin and Corbitt (*42*) in 1925 found that guanidine thiocyanate in doses of 180 milligrams per kilo of body weight caused an increase in the blood sugar of about one hundred twenty-four per cent. within six hours.

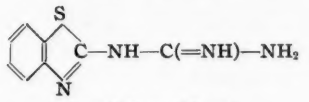
* These syntheses have been presented in some detail in the review on "Liquid Ammonia Research in 1936," by CAPPEL AND WATT, J. CHEM. EDUC., **14**, 174 (1937).

In 1929 Issekutz (*43*) reported that "thioguanide," which is bis(ω-guanidopentyl) sulfide, possessed about the same hypoglycemic activity and toxicity as synthalin B or neosynthalin.*

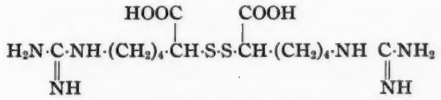
Bischoff and Long (*44*) in 1931 noted that guanidobenzothiazole was very toxic and produced no effect upon the blood sugar when administered intravenously in doses of 50–100 milligrams per kilo. However, in 1935, Samuelson (*45*) reported that this compound showed a slight hypoglycemic action in doses of about 100 milligrams per kilo.



Bis(ω-guanidopentyl) sulfide

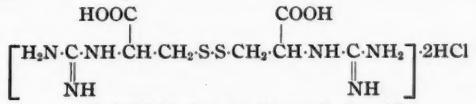


Guanidobenzothioazole

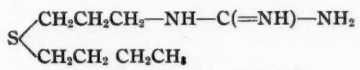


ε,ε′-Diguanido-di(α-thio-n-caproic acid)

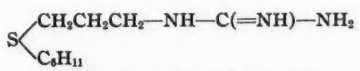
Harwood and Gilman (*40*) studied several sulfur-containing guanidines and found that the sulfate of γ-guanidopropyl butyl sulfide and *N′*-allyl-*N″*-guanylthiourea had no effect upon the blood sugar; the sulfate of γ-guanidopropyl cyclohexyl sulfide increased the blood sugar, and the sulfate of γ-guanidopropyl β-phenylethyl sulfide lowered the blood sugar but was toxic.



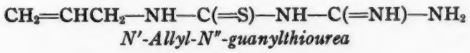
β,β′-Dithiobis (α-guanidopropionic acid)



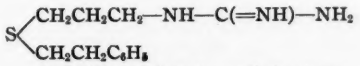
γ-Guanidopropyl butyl sulfide



γ-Guanidopropyl cyclohexyl sulfide

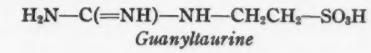


N′-Allyl-N″-guanylthiourea

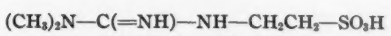


γ-Guanidopropyl-β-phenylethyl sulfide

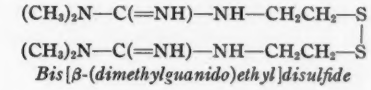
In 1935 Ackermann and Heinsen (*46*) reported that guanyltaurine, asterubin (dimethylguanyltaurine) and bis[β-(dimethylguanido)ethyl] disulfide produced a marked increase in the blood sugar. However, they also noted that bis[β-(guanido)ethyl] disulfide showed a decided hypoglycemic effect on dogs in doses of 40 milligrams per kilo.



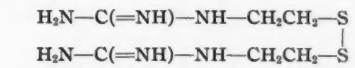
Guanyltaurine



Dimethylguanyltaurine



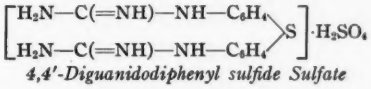
Bis[β-(dimethylguanido)ethyl]disulfide



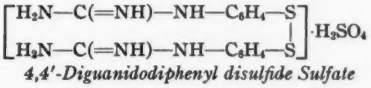
Bis[β-(guanido)ethyl] disulfide

Greenstein and Friedgood (*47*) in 1936 investigated ε,ε′-diguanido-di(α-thio-*n*-caproic acid) and found that intravenous injections of 20–50 milligrams per kilo were without effect; 100–175 milligrams caused some increase in the blood sugar and doses of 200–250 milligrams produced marked hyperglycemia and death in most cases.

Braun and Ludwig (*48*) have shown that β,β′-dithiobis (α-guanidopropionic acid) dihydrochloride (a derivative of cystine), and the sulfates of 4,4′-diguanidodiphenyl sulfide and 4,4′-diguanidodiphenyl disulfide were all without effect upon the blood sugar and were non-toxic when administered subcutaneously in doses as high as 100 milligrams per kilo calculated as free base.



4,4′-Diguanidodiphenyl sulfide Sulfate



4,4′-Diguanidodiphenyl disulfide Sulfate

MISCELLANEOUS ORGANIC SULFUR COMPOUNDS

In addition to the cystinyl peptides and the sulfur-containing guanidine derivatives which have just been mentioned, a number of other organic sulfur compounds, some selected probably because of their availability, have been investigated for insulin-like properties. Many of these compounds were entirely unrelated, but in a few studies the workers restricted their efforts to a systematic study of one chemical class.

In 1927 Izume and Lewis (*49*), studying the effects of substitution of various groups upon the hypoglycemic properties of hydrazine, investigated two sulfur compounds, thiosemicarbazide and "diammonium dithiocarbazate" (hydrazine dithiocarbonic acid hydrazine salt), and concluded that the introduction of thio groupings not only destroyed the hypoglycemic ac-

* Guanidines of the synthalin type and their possible use as insulin substitutes have been discussed in some detail in a review by C. E. BRAUN, J. CHEM. EDUC., **8**, 2175 (1931).

tivity, but also markedly increased the toxicity. The increased toxicity was in direct support of what Lewis (*50*) had found earlier in a study on thiohydantoins and thiopiperazines.

$H_2NNH—C(=S)—NH_2$ *Thiosemicarbazide*

$H_2NNH—C(=S)—SH\cdot NH_2NH_2$ *Hydrazine hydrazine dithiocarbonate*

Shikinami, Yonechi, Kawai, and Hosono (*51*) in 1930 reported that methyl pseudosulfocarbamide (*S*-methyl isothiourea) produced hypoglycemia. The same group of workers in 1931 studied the hypoglycemic properties of a series of isothioureas (*52*), starting with ω,ω'-pentamethylene-di-isothiourea hydrochloride and increased the length of the chain to six, eight, and finally ten methylene groups between the thiourea residues. These isothioureas proved to be only a tenth to a third as active in lowering the blood sugar as the corresponding diguanidines and were just as toxic.

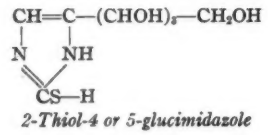
$CH_3—S—C(=NH)—NH_2$
S-methyl isothiourea

$[H_2N—C(=NH)—S—(CH_2)_5—S—C(=NH)—NH_2]\cdot 2HCl$
ω,ω'-Pentamethylene-di-isothiourea Dihydrochloride

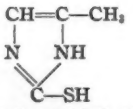
Ruiz, Silva, and Libenson (*53*) in a series of papers on sulfur compounds and hypoglycemia reported that thiophenol, thioacetic acid (methyl carbothiolic acid), and 4- or 5-methyl-2-thiolimidazole all showed slight hypoglycemic activity when administered either orally or by injection. They further reported that certain other thiolimidazoles such as 4- or 5-aminomethyl-2-thiolimidazole, 2-thiol-4- or 5-glucimidazole and ethylene isothiourea (2-thiolimidazoline) were without hypoglycemia properties.

C_6H_5SH *Thiophenol*

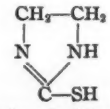
$CH_3C(=O)SH$ *Thioacetic acid*



2-Thiol-4 or 5-glucimidazole

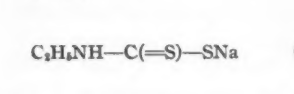


4- or 5-Methyl-2-thiolimidazole

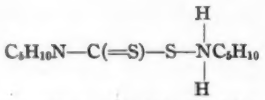


Ethylene isothiourea

Degiorgi (*54*) studied in some detail the effects of salts of alkyl and aryl substituted dithiocarbamic acids upon the blood sugar of normal rabbits and observed that sodium *N*-ethyldithiocarbamate, sodium *N*, *N*-diethyldithiocarbamate, sodium *N*-propyldithiocarbamate as well as the sodium and piperidonium salts of dithio-1-piperidine carboxylic acid produced a marked hyperglycemia.



Sodium N-ethyldithiocarbamate



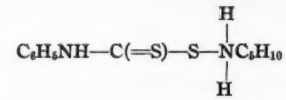
Piperidonium N-piperidyldithiocarbamate

The increase in blood sugar reached a maximum within two hours after administration (oral or subcutaneous: doses 30 mg. upward to 200 mg. per kilo) and the effect lasted more than twenty-four hours.

Ammonium dithiocarbamate, ammonium N-(*p*-aminophenyl)dithiocarbamate and piperidonium *N*-phenyldithiocarbamate produced no hyperglycemia.

$H_2N—C(=S)—SNH_4$ *Ammonium dithiocarbamate*

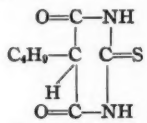
$H_2NC_6H_4NH—C(=S)—SNH_4$ *Ammonium N-(p-aminophenyl)dithiocarbamate*



Piperidonium N-phenyldithiocarbamate

From these observations Degiorgi concluded that substitution of a hydrogen atom of the amino group of dithiocarbamic acid by an alkyl radical increased the hyperglycemic properties but that the size of the alkyl group was of little influence. However, branching of the chain markedly affected the hyperglycemic activity. It was also suggested that the toxicity of such substituted dithiocarbamates depended largely upon the nature of the substituent groups.

Harwood and Gilman (*40*) in their extensive study of sulfur-containing compounds and hypoglycemic activity found that *n*-butyl thiobarbituric acid, dipiperidyl disulfide, dipiperidyl sulfone, and ethyl diethylaminomethyl sulfide were without effect upon the blood sugar. However, thiobarbituric acid, benziminophenyl thioether hydrochloride, and diformamidine disulfide hydrochloride all increased the blood sugar.



n-Butyl thiobarbituric acid

$C_5H_{10}N—SO_2—NC_5H_{10}$ *Dipiperidyl sulfone*

$C_5H_{10}N—S—S—NC_5H_{10}$ *Dipiperidyl disulfide*

$(C_2H_5)_2N—CH_2—S—C_2H_5$ *Ethyl diethylaminomethyl sulfide*

$[C_6H_5—C(=NH)—S—C_6H_5]\cdot HCl$ *Benziminophenyl thioether hydrochloride*

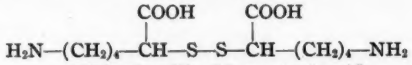
$[H_2N—C(=NH)—S—S—C(=NH)—NH_2]\cdot 2HCl$ *Diformamidine disulfide hydrochloride*

Ackermann and Heinsen (*46*) in 1935 found that taurine and cystamine lowered the blood sugar and that cystamine possessed hypoglycemic activity to a marked degree.

$H_2N—CH_2CH_2—SO_3H$ *Taurine*

$H_2N—CH_2CH_2—S—S—CH_2CH_2—NH_2$ *Cystamine*

Greenstein and Friedgood (*47*) studied ϵ,ϵ'-diamino-di(α-thio-*n*-caproic acid) and its corresponding phenylureido derivative and observed that both compounds exerted no effect upon blood sugar.



ϵ,ϵ'-Diamino-di(α-thio-n-caproic acid)

CONCLUSION

It is apparent from the foregoing presentation that no organic sulfur compound of known structure investigated to date exhibits or even approximates the physiological behavior of insulin. It appears significant that of the numerous sulfur compounds selected from many diversified chemical classes only a very small number even possessed any hypoglycemic activity.

These observations most certainly cannot be interpreted as implying that the dithio linkages in the insulin molecule either are devoid of influence or play only a minor rôle in the physiological activity of the hormone. Entirely too much verified experimental evidence based upon work with crystalline insulin itself has been accumulated to permit the formulation of such a conclusion.

The work to date on synthetic organic sulfur compounds clearly shows that the mere presence of sulfur (even as disulfide sulfur) or of cystinyl or cysteinyl residues in any compound cannot be taken as a basis for assuming that the compound will approximate in any way the physiological behavior of insulin.

From the mass of data thus far produced from the synthetic attack on the discovery of a possible prosthetic group in the insulin molecule, one encouraging observation might be singled out, namely, that certain of the synthetic sulfur compounds were relatively nontoxic, a fundamental consideration if a synthetic substitute for insulin is ever to be realized. This point alone would seem to justify continuation and extension of investigations of this type with special attention being given to derivatives, peptides, and other types of cystine and cysteine.

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FRIEDEL-CRAFTS REACTIONS *for the* ELEMENTARY ORGANIC LABORATORY*

O. C. DERMER

Oklahoma Agricultural and Mechanical College, Stillwater, Oklahoma

MOST beginning organic laboratory courses recognize the importance of reactions catalyzed by aluminum chloride by including one or more Friedel-Crafts syntheses. Because this well-known type of reaction is little used in preparing derivatives for the identification of organic compounds, it must still be taught by the preparation method rather than by the increasingly popular procedures of qualitative organic analysis.

A survey of laboratory manuals reveals considerable divergence among the reactions chosen to represent the Friedel-Crafts synthesis. This is by no means unfortunate, for one way to stimulate interest in preparations is to vary assignments within the class. Nevertheless, when so many alternative reactions have been suggested, it is desirable to find out which ones may best be adapted for use in the elementary laboratory. For the sake of completeness, some of the more advanced preparations described in "Organic Syntheses" and other reference works will be considered.

To make comparisons possible there must be set up a list of criteria for an organic preparation good for teaching use.

1. *Simplicity of Apparatus.*—Does the procedure demand three-necked flasks, motor stirrers, or other special equipment which cannot be supplied to large classes? Most of the preparations in "Organic Syntheses" can be assigned only rarely because of this factor.

2. *Safety.*—Practically all Friedel-Crafts reactions are carried out in inflammable solvents, but those requiring the use of carbon disulfide are particularly dangerous.

3. *Brevity.*—Is the procedure short enough to finish in one or two laboratory periods?

4. *Yield.*—Student satisfaction makes it desirable, though not essential, that the reaction gives a reasonably good yield of purified product.

5. *Cheapness.*—Degering, McCleary, and Padgett (*1*) have suggested the importance of this factor, and have calculated the cost per hundred students of a large number of laboratory exercises.

6. *Ease of Grading.*—From the instructor's point of view, all organic preparations should be odorless white solids, because then foreign odors, off colors, and moisture can be detected readily.

7. *Usefulness of Product.*—Is it of industrial or theoretical importance, or can it be used as a starting material for further experiments?

Table 1 shows the results of a literature survey of Friedel-Crafts experiments. When two or more manuals give slightly different procedures for obtaining the same product, composite estimates have been made. Numbers from 1 through 5 have been used to record estimates of relative difficulty, 1 representing the easiest, and 5 the hardest, procedures. Costs, based on reported yields, are those of twenty grams of product—an ample amount for a student preparation. Current market prices were used and allowances made for the possibility of recovering usable reagents other than the products.

No attempt is made to select the best all-round experiments, for administrators would not agree on the relative weight to be given to the different criteria. It is desired, however, to point out some advantages of the two new reactions included in the table, *i. e.*, those for which no references are given. They have been tested by the author's classes in organic chemistry during the last two years.

1,2-Diphenylethane (bibenzyl) is generally prepared by a Friedel-Crafts reaction between benzene and ethylene dichloride. This reaction was first reported by Silva (*2*). Recently the same reagents have been used in different ratios to produce new synthetic resins suitable for improving rubber (*3*). After testing all the common variables, we have worked out the following procedure.

PREPARATION OF 1,2-DIPHENYLETHANE

Fit a dry 500-cc. round-bottom flask with a reflux condenser and trap for hydrogen chloride. In the flask mix 300 cc. of dry benzene, seventeen grams of ethylene dichloride (Note 1), and eight grams of anhydrous aluminum chloride (Note 2). The latter should be weighed rapidly in a stoppered test-tube to prevent hydrolysis. Heat cautiously under reflux until the reaction begins; then remove the heat source until ebullition nearly ceases. Finally, boil the reaction mixture from half an hour to an hour.

*Presented at the Fourteenth Midwest Regional Meeting of the A. C. S., Omaha, Nebraska, April 30, 1937.

Cool the mixture and pour it into about 250 cc. of cold water. Stir well; then separate the benzene layer and rinse the reaction flask and the aqueous layer with 25 cc. more of benzene. If sediment, collecting at the interface, makes separation difficult, disperse it by adding a little concentrated acid.

Dry the combined benzene extracts over a little anhydrous calcium chloride and distil fractionally. Place recovered benzene boiling from 80° to 90° in the designated shelf bottle. When no more benzene comes off, transfer the residue to a smaller distilling flask, rinsing the original flask once with a very little benzene. Then continue the distillation, using an air condenser. The fraction boiling between 250° and 300°, which should solidify on cooling, is collected as crude product (Note 3).

To purify the crude 1,2-diphenylethane, redistil it from a clean flask and collect that portion boiling between 272° and 282° (corrected) (Note 4). Dissolve this fraction in the minimum amount of boiling eighty per cent. ethyl alcohol, and then, without filtering, chill in an ice bath and stir. The product which separates is filtered out with suction, washed once with ice-cold dilute alcohol, and dried in air. If a yellow tinge persists, repeat the recrystallization.

TABLE 1

FRIEDEL-CRAFTS REACTIONS DESCRIBED BY LABORATORY MANUALS

Preparation	*References*	*Relative Difficulty*	*Working Time (Hours)*	*Averages Yield (%)*	*Cost, Cents per 20 G.*	
					No Recovery	*Recovery*
tert.-Butylbenzene	9	3	12	55	10	8
9,10-Dihydro-9,10-diphenylanthracene	8	3	7–8	40?	15	15
1,2-Diphenylethane	None	1	3–4	70	6	2
Diphenylmethane	1, 4, 8, 9, 10, 13, 14, 18, 20	1–3	3–6	33–53	6–11	5–10
Ethylbenzene	2	1	4–5	64	11	10
Triphenylchloromethane	8, 11, 14	2–3	3–4	68–80	9	7
Triphenylmethane from $CHCl_3$	4, 7, 8, 15	1–3	4–6	33	7–10	4–7
Same from CCl_4	14	2	3–4	60	5	4
3-Acenaphthoylbenzoic acid	9	1	4–5	96	14	9
Aceto-*p*-cymene	1	5	9	53	28	17
Acetomesitylene	8	2	5–6	60	143	143
Acetophenone from CH_3COCl	4, 7, 8, 17, 20	1–3	4–7	50–60	14–22	14–19
Same from $(CH_3CO)_2O$	2, 11	1	4	70	18	16
Same from CH_3COOH	None	2	5–6	40	7	5
Benzophenone from C_6H_5COCl	8, 11, 12, 14, 15, 16	1–3	3–6	74–82	8–10	7–10
Same from CCl_4	1	3	10	85	6	4
o-Benzoylbenzoic acid	4, 8, 9, 15	1–2	4–7	74–96	6–8	5–7
p-Benzoylbiphenyl	19	1	5–6	54	23	23
1-Benzoylnaphthalene	9	3	3	78	12	9
β-Benzoylpropionic acid	1	2	5–6	94	31	30
p-Bromoacetophenone	1, 5	4	5–9	63–74	15–21	12–17
Desoxybenzoin	1	3	8	70	30	27
1,4-Dibenzoylbutane	1	1	12	78	24	18
Diphenyl sulfide	1	4	14	82	6	5
Diphenyl sulfoxide	19	1	3–4	81	16	16
Phenyl thienyl ketone	1	4	15	84	174	169
p-Propiophenol	1	4	13	48	30	28
Thianthrene	8	2	4–5	80	33	30
2-*p*-Toluylbenzoic acid	8, 9	1	4–7	96	8–10	6–7
2-Hydroxy-5-acetobenzoic acid	4	2	3–4	25	63	63

KEY LIST OF LABORATORY MANUALS OF ORGANIC CHEMISTRY

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Note 1. Ethylene dibromide gives a slightly better yield than ethylene dichloride, but is far more expensive unless students have prepared it earlier from ethylene. Smith and Natelson (*4*) preferred to use ethylene oxide.

Note 2. Alchlor, the crude anhydrous aluminum chloride obtainable from the Gulf Refining Company,

is practically as good as resublimed material from chemical supply houses, and costs only a fraction as much.

Note 3. An interesting use for the high-boiling residue (about 10 g.) left in the distilling flask is to add it to another beginning run. This produces ninety-five per cent. conversion of the ethylene dichloride into 1,2-diphenylethane, plus a new residue to be used again. One example of a similar procedure is that of Schramm (*5*). Evidently there is an equilibrium amount of polymers formed in a run, and the addition of this amount represses their further formation. The same principle applies when, in manufacturing phenol from chlorobenzene, diphenyl ether is added to prevent the formation of diphenyl ether.

Note 4. We have carefully redetermined the boiling point of 1,2-diphenylethane. Using a thermometer calibrated with purified alpha bromonaphthalene, which boils at 281.1° (*6*) at 760 mm. pressure, we found the corrected value to be 280–280.5° instead of 284° (*7*).

PREPARATION OF ACETOPHENONE

The use of a free acid, instead of an acid chloride or anhydride, in the Friedel-Crafts ketone synthesis has been studied by Groggins, Nagel, and Stirton (*8*) and patented by Groggins and Nagel (*9*). They suggest that the mechanism of the acetophenone synthesis involves the steps

$$CH_3COOH + AlCl_3 \longrightarrow CH_3COOAlCl_2 + HCl$$
$$CH_3COOAlCl_2 \longrightarrow CH_3COCl + AlOCl$$
$$CH_3COCl + C_6H_6 \xrightarrow{AlCl_3} CH_3COC_6H_5 + HCl$$

In support of this idea they have isolated acetyl chloride by distilling a mixture of aluminum chloride and acetic acid. The free acid is a much cheaper reagent than the acid chloride or the anhydride; but it must be noted that unless cheap aluminum chloride is available, the larger excess required will keep the cost high. We have not been able to duplicate the yields reported by Groggins and co-workers, but even so the cost of preparing acetophenone by the following method is less than half that calculated for others.

Fit a 1-liter round-bottom flask with a reflux condenser carrying a dropping funnel and a delivery tube leading to a trap for hydrogen chloride. In the flask place 200 g. of dry benzene and 200 g. of crude anhydrous aluminum chloride (Alchlor). (Weigh the aluminum chloride rapidly in a closed container, for it is extremely hygroscopic.) Through the dropping funnel add gradually 30 g. of acetic acid, shaking the flask occasionally to prevent caking. Finally heat the reaction mixture to boiling and maintain it at that point for two hours (Note 1).

The cooled mixture is cautiously hydrolyzed by adding ice water from the dropping funnel and cooling externally as long as there is any reaction. It is then distilled in the same flask by passing in steam and collecting the distillate so long as two layers come over; this generally means collecting about 800–1000 cc. (Note 2). The benzene layer of distillate is separated, dried over anhydrous calcium chloride and distilled fractionally. Recovered benzene boiling from 80° to 90° is placed in a shelf bottle designated for the purpose. The product boiling from 195° to 205° is collected and weighed as crude acetophenone. It may be purified by redistillation.

Note 1. Calloway and Green (*10*) have recently pointed out that it is not necessary nor desirable to boil the reaction mixture as long as hydrogen chloride is evolved. Heating for two hours gave practically as high yields as did the longer heating (seven hours) specified by Groggins and co-workers.

Note 2. We also attempted to isolate the product by separating the benzene layer immediately after hydrolysis and then distilling. Separation of the emulsion, however, was rendered practically impossible by the large quantities of tarry aluminum hydroxide formed, which could not be dissolved by adding strong acid.

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By cherishing as a vital principle an unbound spirit of inquiry, and ardency of expectation, it unfetters the mind from prejudice of every kind and leaves it open and free to every impression of a higher nature, which it is susceptible of receiving, guarding only against enthusiasm and self-deception by a habit of strict investigation, but encouraging rather than suppressing everything that can offer a prospect or a hope beyond the present obscure and unsatisfactory state. . . . . —SIR JOHN HERSCHEL

The CHEMIST *at* WORK

ROY I. GRADY AND JOHN W. CHITTUM

The College of Wooster, Wooster, Ohio

XIV. MY WORK WITH CHEMICAL ABSTRACTS

JANET D. SCOTT

The author of this paper describes her work as Associate Editor of Chemical Abstracts. *In 1923 Miss Janet Downing Scott graduated from Vassar with honors. During the next year she held the Vassar Alumnae Fellowship and studied at the University of Chicago where she later received the degree of Master of Science. She served as assistant to Dr. Austin M. Patterson, Chemistry Editor of Webster's New International Dictionary, Second Edition. In 1930 she joined the staff of* Chemical Abstracts *and in 1935 was promoted to her present position.*

Miss Scott is a member of Phi Beta Kappa.

✦ ✦ ✦ ✦ ✦ ✦

Then what is there left for you to do in your office? is the natural question of one who has been informed that the actual abstracting for *Chemical Abstracts* is done by over four hundred abstractors scattered throughout the United States and other countries and that there are fifty assistant editors outside the office in charge of the thirty sections of the journal. Yet with approximately sixty-five hundred abstracts appearing in a year, some twenty-five full-time workers with extra helpers at rush periods find more than enough to keep them busy in the main office. The rush periods sometimes are long ones, as the present three-year period of work on the Third Decennial Index, for which the office staff was increased over fifty per cent.

There are many phases to this work in the editorial office. Questions of organization, general policy, finance, printing arrangements, and the like are settled here with the coöperation of the Directors of the American Chemical Society. A staff of competent abstractors must be kept complete and active. Subscriptions and exchanges must be arranged for a large portion of the twenty-eight hundred journals abstracted. Records must be kept of the journals received and of those sent out to abstractors and to outsiders requesting loans. Journals not covered regularly by individual abstractors are assigned in the office, article by article, according to the interests and linguistic abilities of the various abstractors. All assignments and abstracts sent in without assignments are checked with the previous year's index and with the current author index (which, in the form of a card file, is a record of all published and unpublished abstracts and of all assigned papers) to avoid duplication and to correlate the work of authors. Another phase of the checking involves going over about two dozen abstract journals and journals with abstract sections to catch any chemical articles that *Chemical Abstracts* may have missed. The manuscript as it comes in from the abstractors usually requires some editorial attention before it can be sent to the printer. Twenty-four of the assistant editors examine abstracts for their sections in manuscript form (all see proof), but most of them are read again in the office. Patents are abstracted by special abstractors, and these abstracts must also be edited in the office and checked for duplicates and correlations. Galley proof, in addition to being read by the assistant editors, is read also by the abstractors for some sections, and it is all checked with manuscript and read again in the office. The four annual indexes, author, subject, formula, and numerical patent, constitute one of the biggest jobs of the main office, while the author and subject decennial indexes are of course still bigger jobs.

All of this work, with its great variety and volume, moves along in definite cycles in conformance with the semimonthly schedule of the journal and the annual and decennial schedules of the indexes. Hence many of the workers in the office take part in several tasks, in rotation. My own work involves chiefly helping on manuscript editing, proofreading, and subject-indexing.

Manuscript editing involves four chief considerations. First, is the abstract suitable for use in *Chemical Abstracts?* In other words, is the subject matter chemical, or, more broadly, is it of interest to chemists? This attempt to define the boundaries of one science leads to many difficulties, since the interests of the various sciences overlap to a very large extent. Where, in particular, does chemistry end and physics begin? In such matters as subatomic phenomena and radioactivity there no longer is any dividing line, and practically all articles on these subjects seem to have some bearing on chemistry. Are all cosmic ray studies, however, of interest to chemists? In some fields, as in metallurgy and textiles, strictly physical tests are usually carried out by the chemist; hence they belong in *Chemical Abstracts*. Articles, and patents on apparatus and plant equipment, furnaces, centrifuges, and the like used in chemical processes are of interest to chemical engineers. But are gas burners, incinerators, electric condensers, heaters, photometers, X-ray

tubes, for example, always of chemical interest? Again, in the field of biochemistry the line between chemistry and physiology is a most difficult one to draw. Thus, have the studies of non-chemical effects of organ extracts and more or less pure preparations of hormones any real relationship to chemistry?

Once an abstract has passed as suitable in subject matter, the next question is: Is it too long (or less often, too short)? Considerations here involve the degree of chemical interest, the newness and probable

SUBJECT INDEX ENTRIES FOR COAL AND CELLULOSE, RESPECTIVELY, ARE SHOWN TO THE RIGHT. THE CORRELATION OF ENTRIES FROM YEAR TO YEAR IS AIDED BY THESE PASTED SHEETS

value of the material, the accessibility of the journal containing the original article and the language in which it is written, and the general interest to chemists (especially in this country, if, for example, natural products of far-off lands are under discussion). There is also involved the practically mechanical elimination of needless words and phrases here and there, such as the favorite "It was found (or shown) that. . ." Many short-cut words can often take the place of several words each.

The third question is: Is the abstract in the proper form for the printer and does it seem correct in details? The matter of form includes the abbreviations for the journal references and for the commonly occurring words in the official list, the *Chemical Abstracts* preferred spellings and in certain cases the preferred names for chemical compounds, pharmaceutical preparations, etc. Considerations of English and sentence structure are all-important. Jumbled singulars and plurals (such as data is), mixed tenses and mixed verb forms (particularly imperative and passive voice), dangling participles, and ambiguous and conflicting statements are common mistakes. In abstracts of articles in foreign languages translation mistakes and the awkward English of foreign abstractors need careful watching. It is all too easy to bring over into English the construction of a foreign sentence or to use the English word closest in form to the foreign one (or to make up a corresponding English word) rather than to provide the most suitable translation. Thus in English we are not so fond of whereby clauses as are the Germans, nor do we use dosage and titration for determination, or cokefaction for coking, or speak of pulverizing liquids as the French do. Other questions in regard to correctness are: Does the abstract as a whole make sense? Does the chemistry seem sound? Are the formulas and equations possible? If the answer to any of these questions is no, it may be necessary to go back to the original journal, if possible (even articles in Russian, Chinese, Japanese, and other "outlandish" languages often yield information in the form of equations, formulas, tables of data, graphs, or summaries in other languages), or to turn to *Chemisches Zentralblatt* or *British Chemical Abstracts*. In some cases abstracts have to be sent back to the abstractors, passed on to specialists (usually the assistant editors), or held for further information. Other troublesome problems are the uses and misuses of words and the spellings and forms of unusual or new words like geographical, botanical, zoölogical, and bacteriological names and trade names, often not to be found in dictionaries or reference books. For example, is glycogenesis in a given abstract used improperly for glycogen formation (which should be glycogengenesis) or properly for sugar formation? The original German title has Glycogenese, but the article also uses the word Glykogenbildung and deals with glycogen formation. Is kermek used for making a tanning extract the same as kermes? The original Russian journal is not available; *Chemisches Zentralblatt*, which has an abstract, uses Kermek; our books are of no help; the botany and zoölogy librarian cannot find it either. Therefore we are forced to use kermek and index it so. Again, what can gyp be? It turns out to be not gypsum, but calcium carbonate in oil field terminology. Sonim is used in metallurgy for non-metallic inclusions. Tri stands for trichloroethylene, B.O.D. for biochemical oxygen demand in sewage studies, and so on. Each industry and branch of chemistry has its own "lingo."

The last question in manuscript reading is: What section of *Chemical Abstracts* seems most suitable for this particular abstract? Here again the decisions are often difficult to make because of overlapping interests. Probably the subsections in the biological section present the most problems, but by no means all of them. Vitamin studies usually go in *Nutrition*, but what about a study of beriberi not specifically related to diet? Would a study of the gland secretion of alligators be better in *General* (biological chemistry) or in *Zoölogy?* Is the organic chemist or the biochemist more interested in the structure of enzymes, hormones, vitamins, and other naturally occurring compounds? Is the

sewage chemist or the textile chemist more interested in the disposal of waste from textile mills? In cases in which two or more sections seem almost equally appropriate, cross-references are made from the sections not chosen. Abstracts are not usually read before they are placed if it is apparent from the titles that they belong in a section whose head (assistant editor) wishes to see the manuscript, but are edited when they come back from him.

The problems of proof-reading are similar to those of manuscript reading with the additional one of watching for typographical errors. Occasionally, an abstract must be held out of proof for subsequent settling of a troublesome point. Typographical errors, besides errors in spelling, punctuation, capitalization, the use of heavy-face and italic type, include a few mistakes peculiar to chemical subject matter such as the use of sub- and superscripts with symbols, and not always obvious confusions like Co and CO, Hf and HF, syenite and cyanite, secretion and secretin, precipitation and precipitin, calorimeter and colorimeter, adsorption and absorption, phosphorous and phosphorus, and phenethyl and phenetyl.

The annual indexes consume the greater part of the time of most of the office force for about four months of the year, and a large share of the time of a few during the whole year. Ordinarily, I do not help on the author index, but occasionally I am called on in connection with the entries under large companies like the I.G. Farbenindustrie, where the problems resemble those of the subject index.

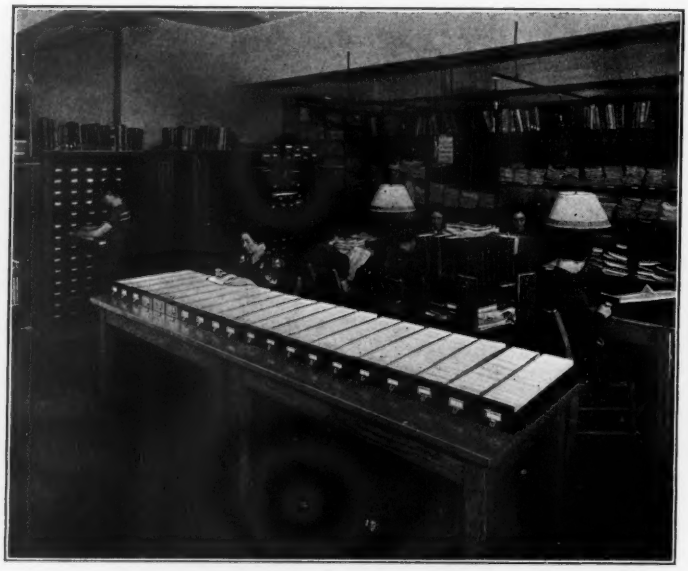
The subject index is more and more my chief job. It includes part of the selection of entries to be made (by marking the printed numbers or page proof of the journal), editing of index cards, taking charge of the proof, and proofreading. The marking consists in underlining or writing in the words for the headings of the particular entries desired. This involves considerations not only of *what* and *how many* subjects should be entered, but also *how* they should be indexed. As the aim of the *Chemical Abstracts* index is to be a *subject*, not a *word* index, to approach consistency and avoid scattering, the words used in the abstracts are often not the words used as headings. Thus aspirin is entered as *Acetylsalicylic acid* and mustard gas as *Sulfide, bis(β-chloroethyl)* (the indexing of all but the simplest organic compounds, according to the *Chemical Abstracts* system of inverted names, is done by two specialists in the office). Electrolytic dissociation goes at *Ionization, electrolytic*. Gaseous ions of hydrogen belong under *Protons*, while gaseous molecular ions of hydrogen are entered at *Hydrogen* and *Ions, gaseous*. Where then do the so-called H-rays belong? Again, is energy exchange in the animal organism to be considered metabolism? Where should the confused flour beetle be indexed: under its common name (beginning confused, flour or beetle?) or under *Tribolium confusum?* In cases of doubt as to the meaning or usage of words or obscurities in regard to the author's ultimate purpose, word indexing must be resorted to with cross-references among headings of related interests. Differences in emphasis and in points of view in similar studies also lead to numerous indexing difficulties. At times, too, adequate indexing entails going beyond the obvious entries by indicating possible interests in other fields. Compounds requiring formula index entries are marked with colored pencils for other workers to make the formula cards. The subject index cards are typed from the marked copies and then checked for the wording of the modifications (the phrases entered under the headings to provide descriptive detail). I have done a small amount of this checking.

Editing the cards after they have been alphabeted nvolves not only the mechanics of crossing off headings that are alike, and attention to details of form (often taken care of by other workers), but watching headings

THOUGH THIS IS THE LARGEST SAFE-CABINET OF ITS KIND MADE AND THE INDEX CARDS ARE OF THIN PAPER (NOT CARDBOARD) THE CABINET SHOWN HOLDS ONLY ABOUT ONE-FIFTH OF THE CARDS

for duplications and overlappings, checking cross-references (made from preceding indexes) by means of a system of inverted cross-references for their suitability for use in that particular year, transferring entries to other headings, eliminating entirely or rewording entries that are affected by specific cross-references, and grouping or combining similar modifications (with the most suitable wording) under any one heading. Thus if there is a heading *Peanut meal* and an entry about meal under *Peanuts*, this entry must be transferred to the former heading. Without cross-references scattering may easily occur under headings far apart like *Hookworm, Ancylostomiasis* and *Ankylostomiasis, Foot-and-mouth disease* and *Hoof-and-mouth disease,*

Epiphysis and *Pineal body*. In the case of those elusive substances the hormones, word indexing or combined subject and word indexing seems unavoidable, for preparations designated by one investigator as prolan or estrin or folliculin may be quite different from those given these same names by another. Changes particularly in these newer fields sometimes have to be made during the editing of the cards at the end of the year because of new information that has come along during the year. Further, the modifications are supposed to begin with the most significant word, but often two or more words may be of almost equal importance. For an entry under *Phosphorus*, for example, about the phosphorus-nitrogen ratio in bones, would it be better to begin with -in bones or -nitrogen ratio? Entries that say the same thing in different words (as purification of and refining of, under *Benzene*) should of course be combined. Sometimes, however, it is not easy to tell when two or more entries do deal with the same type of study.



GROUP OF INDEX WORKERS. THE TWENTY BOXES OF INDEX CARDS (THIN PAPER) IN THE FOREGROUND CONSTITUTE LESS THAN ONE-TWENTIETH OF THE INDEX. THERE ARE FOUR HUNDRED SEVENTEEN 25-INCH BOXES OF CARDS ALTOGETHER

In proofreading the subject index the same things must be watched for as in editing the cards, and in addition, details of printing form. Many desirable changes show up in the more compact printed form (which the eye can readily scan) that are not readily apparent in the more bunglesome form of cards (which the hand must shuffle through one by one). Taking charge of the proof means that I keep track of the various stages it goes through: checking of the galleys with the cards, proofreading, reading for alphabetical order, surveying by the editor, and checking of the page proof with the corrected galleys; and that I add corrections noted for the galley and page proof and send the proof back to the printer on schedule.

The formula index is of concern to me only in proof. This we read aloud in pairs, one checking the cards and the other the galleys. A few hours of choice bits like $C_{16}H_{30}N_4O_5$ Butyric acid, (aminobutyrylamino)-butyrylamino-, 104[8] and $C_{20}H_{28}N_2O$ Δ^2-Pyrazoline, 5-(2-furyl)-1-phenyl-3-(1-piperidylethyl)-, *-HCl*, 4797[9] is enough to make us reel, but fortunately this lasts only three to five days.

The decennial indexes, far from being simple compilations of the annual indexes, require complete reediting of the accumulated cards. Difficulties not apparent in any one year's index may loom large when ten years' indexes are brought together. Advances in knowledge during the ten-year period often throw new light on many indexing problems and lead to many improvements in the cumulative indexes.*

Along with the assigning, editing, printing, and indexing of some six thousand abstracts a month, other special jobs arise, especially in the line of nomenclature problems, many of which are referred to the *Chemical Abstracts* office by chemists from far and near. And so the answer to the question of what there is left to do in the *Chemical Abstracts* office proves to be a many-sided, complicated one.

[Those who are to succeed as chemical abstractors must have certain distinct characteristics and definite training differing from those who would engage in many other lines of chemical activity. On the other hand, most of the requirements listed by Miss Scott as being desirable in an abstractor might well be considered by any chemist. We are, therefore, presenting Miss Scott's complete statement.]

Because of the many fields covered by *Chemical Abstracts*, a broad training seems more desirable than specialization in any one branch of chemistry, except for the job of organic indexing, which involves particularly problems of nomenclature probably not taught in any course. At least a certain amount of training in all branches of chemistry, including biochemistry and chemical engineering, is advisable, and also a bibliographical or library (literature research) course. Some acquaintance with almost every branch of science would be of value, but particularly physics, biological science (physiology, biology, or zoölogy), mineralogy,

* For a discussion of some of the problems that have arisen in connection with the Third Decennial Index, see E. J. CRANE, *Industrial and Engineering Chemistry, News Edition*, **15**, 175 (1937).

and crystallography. Fully as important as the scientific training, however, is that in English and foreign languages. Technical or critical writing courses with careful attention to sentence structure, clarity, brevity, and correct use of words would be the best type. A reading knowledge of German and French is essential; from the former some Dutch can be made out and from the latter some Italian and Spanish. Since the volume of scientific work in Russian is increasing by leaps and bounds, some knowledge of Russian would be of great help; this would also be a key for unlocking some of the mysteries of other Slavic languages. Enough Latin and Greek to aid in working out the derivations of words would also be desirable without being essential.

Among personal characteristics for this type of work accuracy perhaps should rank highest, and with that conscientiousness, patience, a meticulous attentiveness to detail (without a loss of perspective of relative values, since a great deal of work has to be turned out, at times under considerable pressure), power of concentration, good judgment, and interest in words as words, a love of puzzles and of guessing and digging out elusive ideas, meanings, words, and formulas. An interest in *things* rather than *people* is likely to lead to greater satisfaction in this type of work, since the opportunities for personal professional contacts outside the office are relatively few. The analytical rather than the creative type is probably best suited to this kind of work. Good eyes (at least *strong* ones) are absolutely essential, while the ability to *sit* hour after hour without much relief is a requirement not to be laughed off. Work of this nature is not for the overly energetic or restless person.

XV. THE CHEMIST IN THE PHARMACEUTICAL INDUSTRY

RANDOLPH J. OWEN

Some of the problems which confront the control chemist in the pharmaceutical industry are described by Mr. Randolph J. Owen. Mr. Owen has been connected with the E. L. Patch Company, manufacturing pharmacists, since 1925. For eight years he was employed as a chemist and since 1933 he has been plant superintendent. He is a graduate of Boston University and is the co-author of several papers.

The accompanying picture shows the completely remodeled up-to-date control laboratory of the company.

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The pharmaceutical industry is one in which the chemist plays an important part. Many branches of chemical work may be found represented in this industry, some of which are analytical, organic, research, and biological. In this paper I will describe only the work of the analytical chemist who is directly tied up with the production of goods which are used to fill orders. Such a chemist is usually assigned to a department known as the Control Department.

The Control Department in a pharmaceutical company is responsible for two principal duties. These are the control of quality of raw materials and control of finished goods. Other duties include research on methods of analysis, improvement of existing processes, and development of new products.

The control chemist, in carrying out the work of the department, must make use of a great many branches of the science of chemistry. In addition, the control chemist is constantly making observations and comparisons upon many physical characteristics such as color, flavor, and odor.

In controlling the quality of raw materials that are to be used in our products, the first step is to obtain samples from several manufacturers. These samples are examined in various ways, depending upon the item and use to which it is put. From the results of the examination, a source of supply is chosen. Future purchases should be made from this source. Should it become desirable at any time to change the source of supply, new samples should be obtained and examined before buying any quantity.

Having selected a satisfactory source of supply, raw materials are purchased. When shipments of raw materials are received, samples are examined by the Control Department.

"The United States Pharmacopœia" is taken for a standard. "The United States Pharmacopœia" is a book which contains the names of drugs and chemicals most widely used by physicians, either alone or in mixtures with other drugs and chemicals in the treatment of disease and relieving the discomfort of the various ills to which mankind is subject. Following the name of each drug or chemical is a description and list of physical properties and a list of reliable qualitative tests for identity and for various impurities. In addition there is a method for a quantitative analysis and a statement of the degree of purity to which it should conform. The Food and Drug Law requires that all drugs and chemicals used for medicinal purposes be of United States Pharmacopœial quality.

A typical chemical listed is ammonium chloride. A sample of a white crystalline salt is received marked ammonium chloride. First it is identified by making qualitative tests in a test-tube for ammonia and for chloride. Ammonium chloride on ignition should volatilize without fusion. Then tests for impurities are made. Ammonium chloride should not show an immediate acid reaction, should not show the presence

of heavy metals, nor give a positive test for thiocyanate. If the tests for identity and purity are satisfactory, a quantitative analysis by the volumetric method is used. The salt should contain not less than 99.5 per cent. ammonium chloride.

I recall testing a sample of ammonium chloride several years ago and finding a positive test for thiocyanate when there should have been a negative one. After one such experience as the above, a chemist realizes that all the tests for impurities are necessary. Extreme accuracy and care in testing every batch of material are the essential characteristics of a good control chemist. *Thoroughness* is a good watchword.

The finished preparations may be described under some one of the following principal groups: solution, sirup, lotion, emulsion, powder, ointment, suppository,

PHARMACEUTICAL LABORATORY OF THE E. L. PATCH COMPANY

or tablet. There are a number of other types of preparations not included in this list. When a batch of any preparation has been made up by a manufacturing department, the Control Department is notified. A representative sample is taken for examination. Odor, taste, and appearance are three important physical characteristics which are examined. Comparison is made with standard samples.

Accurate analysis is important from the viewpoint of the physician who is relying on the manufacturer for preparations containing definitely known doses of powerful drugs. The alkaloids are among the drugs for which the physician must have accuracy of dosage. Alkaloidal assays are interesting because of the many principles of chemistry illustrated. Some of these principles are volumetric analysis, weighing on the chemical balance, extraction with immiscible solvents, and the laws of solubility.

Ten to twenty tablets from each batch are weighed to make sure that the per cent. variation between the highest weight and the lowest weight does not exceed a predetermined limit; also, to see if the average weight is identical with the calculated weight. Many chemical compounds in their pure state may be analyzed quantitatively without any difficulty. When they have been combined into various mixtures the work of analysis is increased two and threefold. This is illustrated in the cases of many tablet mixtures. Organic compounds mixed together are often hard to separate completely and without decomposition. These time-consuming determinations must be made carefully as the Bureau of Drug Control requires extreme accuracy in conforming to the Pure Food and Drug Laws.

Not until the Control Department puts their O.K. on a batch of any preparation is it allowed to be bottled and put into stock.

Now the question arises as to what happens when, upon examining a sample of a batch of a finished preparation, we find it does not measure up to standards. Occasionally such a situation is met. It is the duty of the Control Department to find out what is wrong and what the remedy should be. To do this, it is often necessary to do some detective work to find causes. The process followed can best be understood by following through an actual case.

A sample of sirup mixture was received. A comparison was made with a standard sample. A difference in color was noted. The standard was a clear, dark amber while the sample was light-colored, pale yellow. In all other respects, the two liquids were alike. Then the material was examined. It was noted that all the materials had been weighed by the workman and weights checked by the stock clerk. Neither of these men, when questioned, could recall any unusual circumstance. Both agreed that all the ingredients were put into the mix. The foreman of the Manufacturing Department could find nothing out of the way.

Then we went back to the laboratory and studied the formula. We considered only the ingredients that contributed to the color of the sirup. There were two such ingredients. From our experience in handling these two ingredients, we deduced the fact that one contributed more to the final color of the preparation than the other. This one was caramel. So we asked ourselves the question, Was the caramel put into the mix? A small amount of the sirup was obtained and caramel added in small portions until the color matched the standard. Calculations were then made to find the amount of caramel needed for coloring the entire batch of sirup. A coincidence was noted which was that the amount of caramel needed was identical with the amount called for by the formula. Circumstantial evidence was that the caramel was not put into the mix, although two men were sure that it was weighed out and put in. It was ordered that the necessary amount of caramel be put in to make the color match the standard.

Trouble with another preparation was not so easy to locate. The preparation was a clear, pale yellow liquid. We had made lot after lot of the preparation for several years with no trouble. One lot, after standing about thirty days, had precipitated a fine suspension, black-colored, which made the liquid appear

brownish black. This precipitate defied filtration. It was so fine it would pass through filter paper. Filter aids were of no use. It was thought that the water supply might have caused the trouble. The purest distilled water available was tried without success. Every lot turned dark.

The problem was tackled in the Control Department. The first step was to take each ingredient, mix it with distilled water, and set it aside for observation. The results were negative.

The next step was to make every possible combination of two of the ingredients with water. After a few days a slight discoloration was noted in one mixture which was the slow formation of a black precipitate. This showed the way to solve the problem. It was necessary to change one ingredient.

Although changing one ingredient gave a mixture which was satisfactory, it did not answer the question of why the discoloration. We had made the preparation for years without trouble and at the time, samples three years old were bright and clear without a sign of discoloration. There we stood unable to duplicate what we had once accomplished.

A search of chemical literature was made. Reference was found to an incompatibility of these two chemicals. The authors claimed that there was a discoloration due to an impurity in one of these chemicals. We concluded that a trace of impurity in one of these chemicals used in this preparation had caused our trouble.

There is also the work of improving methods of analysis. There are some old familiar chemicals for which practical methods of analysis have never been developed. Work is constantly progressing on new methods of analysis. Frequently, it has been found difficult to separate some organic chemicals from one another. This has made the accurate control of tablet-mixture at times difficult. New chemicals are frequently being introduced and used.

The routine portions of the work may, for some people, become monotonous. The variety of the usual problems that arise to be solved creates spice and interest in the work.

XVI. THE CHEMIST IN THE CANNING INDUSTRY

E. F. KOHMAN

Dr. Edward Frederick Kohman received his A.B. degree from Kansas in 1912 and Ph.D. degree from Yale in 1915. After serving two short appointments he joined the Research Laboratories of the National Canners Association of Washington, D. C. Recently he joined the Research Department of the Campbell Soup Company at Camden, New Jersey.

Dr. Kohman is the author of a number of articles dealing with vitamins and canning, corrosion, and related phenomena. From his work on such problems he gives this description of the chemist at work.

He is a member of the American Chemical Society.

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The fundamental principles involved in corrosion are well known. Yet it was in connection with corrosion that occurs on the inside of a can of food that I encountered a fascinating problem. This subject had already received intensive study. Many thousands of dollars had been spent on coöperative studies of tin plate by the canning industry, the steel industry, and the Department of Agriculture. Under the circumstances, it might not have appeared to be a profitable field for a young inexperienced chemist to tackle. Under such circumstances one is not in a position to ask for more monetary support than the very moderate funds necessary to keep a laboratory chemist supplied with reagents. In the face of that, I requested permission to study the question of corrosion in a can of food from the standpoint of the composition of the foods. Before long, the facts disclosed were sufficient to carry the study through several years of interesting adventure.

The rôle of oxygen is always recognized in any corrosion study. The canning industry was quite aware of the necessity of excluding oxygen as completely as possible in canning. Nevertheless, I made a rather detailed study of the oxygen content of various foods and various phases relating to it. At that time, it was the practice in the canning industry to submerge apples, after peeling and quartering, in a salt solution, overnight, at a cool temperature, to prepare them for canning. It was known in the industry that by so doing the apples retained a bright color and they did not corrode the can, while without this procedure it was practically impossible to can apples because of their excessive corrosive action on the can. My part in this was merely to show that the respiratory process in the apples consumed their oxygen content during this submerging process. This observation had no practical bearing at the time in connection with corrosion but a little later I will relate how it did have a practical bearing.

Then I made a detailed study to determine certain quantitative relationships between oxygen and corrosion in the can. It was possible to demonstrate the

effect of a very few cubic centimeters of oxygen in a can of fruit. In itself, this observation was of little practical value because the industry was already aware of the necessity of excluding oxygen as efficiently as possible and methods to do so were, in the light of this quantitative aspect, sufficient at the time. Nevertheless, some side observations indicated factors of significance. Since I had been taught, and since every textbook that I had ever seen indicated that tin is a more noble metal than iron, this idea was a background for my study. The experiment involving small quantities of oxygen caused a questioning of this relationship. To make a long story short, tin is a more noble metal than iron whenever oxygen is present. In the absence of oxygen, and in contact with any of the fruits that are canned, tin becomes the anode and iron the cathode. Naturally, this observation at once put an entirely different aspect to the whole corrosion problem. It explained many things that heretofore seemed contradictory or entirely unexplainable. It led to the study of other factors that might shift the electro-chemical relationship between tin and iron as they occur in a tin can, as well as to a number of details radiating from this relationship.

While canners can exclude elementary oxygen in canning, there are various constituents of certain fruits —particularly the red berries and the black and red cherries—that may act comparably to oxygen in certain respects. For example, the anthocyanin pigments have a grouping in which oxygen is said to be tetravalent and has strong oxidizing properties. It has been found that these fruits do have a decided corrosive action on the can under certain conditions and that the anthocyanin pigment or color is definitely involved. Fruits may also contain compounds having an unsaturated group which may act as hydrogen acceptors. These are particularly involved in connection with the high overvoltage that develops on tin since they tend constantly to depolarize the tin.

It is a well-known fact that the concentration of the ions of any metal definitely influences the single potential of that metal in any medium. There is a tendency for stannous ions to form complex combinations with other ions and, in this way, their concentration is reduced. The tendency of this is to make tin more anodic, that is, less noble. Proteins and other fruit constituents have a tendency to absorb stannous ions. Most of the tin that does dissolve in any fruit lodges in the fruit pulp in an insoluble form. In the case of strawberries, most of the dissolved tin is absorbed by the seeds. If the pits of cherries are broken before canning, corrosion is greatly augmented. A few peanuts in a can of fruit has a marked effect on intensifying corrosion.

It is almost an axiom that increased acidity increases corrosion. However, in canned fruit this is not true. In the tin-iron couple we have found that as the acidity increases from a pH of about 4 down, the anodic relationship of tin to iron becomes more and more pronounced. A practical application of this is that the corrosion of the less acid fruits, such as prunes, sweet cherries, and blueberries, can actually be markedly lessened by the addition of an acid such as citric acid, malic acid, etc. An actual commercial application of this is to add lemon juice to prunes in order to supply a higher concentration of citric acid.

In considering the corrosion in canned fruit, two types of cans must be accounted for—namely, a plain can and an enameled can. A plain can is what the designation implies—that is, no inside coating is used. An enameled can is one in which the inside surface of the can is coated with a lacquer which has been baked on at a relatively high temperature, giving it the smooth, hard reflecting surface comparable to enamel.

There is no can so perfect, whether plain or enameled, as not to have both iron and tin exposed to the contents. In a plain can, the area of tin exposed exceeds by many times the pin-point areas of exposed iron. Since the tin is anodic to the iron, its relatively enormous area affords very effective electrochemical protection against corrosion of the iron. The tinned surface corrodes very little because of the high overvoltage that promptly develops. It has been found that tin ions in concentrations of a very few parts per million afford very effective inhibiting properties against the corrosion of iron. In a plain can, there is a certain concentration of tin ions which, in addition to the electro-chemical protection, acts as an inhibitor against corrosion of the iron. As a result, very little difficulty is experienced in consequences of corrosion resulting in perforation of the iron base in a plain can.

In an enameled can, the picture is different. The great bulk of the tin surface as well as some of the pin-point surfaces of iron are covered by the enamel and thus removed from the corrosion picture. In consequence of this, while the area of tin exposed still may be greater than the area of exposed iron, the proportion of the exposed tin has been drastically reduced; every area of exposed iron, even though a pin-point area, since it is the cathode, tends to cause tin corrosion adjacent to it. In this way, the area of exposed iron gradually becomes larger. The effect is self-propagating, so to speak, until the area of exposed iron may exceed that of the exposed tin. The ultimate effect sooner or later is that the exposed iron area at a given point may be large enough to undergo corrosion in a manner comparable to iron without tin being involved—that is, local couples may form on the iron itself. Since the overvoltage on iron is so much less than on tin, this corrosion in an iron couple might naturally be much more rapid than when tin is the anode. Sooner or later the can becomes perforated through this action. It is a well-recognized fact in the industry that, while plain cans very seldom perforate, enameled cans do perforate —particularly when fruits with low acidity and abundant anthocyanin pigments are involved. These pigments, as well as unsaturated hydrogen acceptors, account for the appearance of hydrogen in only a small fraction of the molecular proportions of tin and iron that corrode.

It seems a far cry from the study of corrosion to a study of vitamins. Yet a mere following of details bridges the gap. When the vitamin story first began to be developed, there seemed no indication that the canning industry would be under the necessity of taking any cognizance of it. The first reaction was that if vitamins are present they are canned. Soon in the history of vitamins, however, someone pointed out that when cabbage is cooked about 90 to 95 per cent. of the vitamin C is destroyed. It did not take long for someone to point out that the canning industry uses higher temperatures and probably longer times for cooking most products than is employed in ordinary home cookings. Fortunately for the canning industry —and this is the detail that bridged the aforementioned gap—it was shown about the same time that vitamin C is very susceptible to destruction by atmospheric oxygen. It was logical to infer that, since in canning all fruits and vegetables oxygen must be eliminated efficiently, there might be the possibility of a compensating effect in less vitamin C destruction. Here the observation that apples, when covered with a dilute salt solution, consume all the oxygen within their tissues, presented its practical application. Incidentally, the salt in the water was merely to prevent the darkening of the apples during this holding period.

It was a simple experiment to can apples on the one hand as any housewife would do it and, on the other hand, in an exactly similar manner but after the apples had been submerged in a weak salt solution until they had consumed all the oxygen within their tissues. After a feeding experiment involving the two groups of apples, together with several other groups of apples, one in which the gas in apples had all been replaced by oxygen, another by nitrogen, and still another by carbon dioxide, etc., merely to bring out the actual facts in a more definite manner, there remained no doubt as to the efficacy of the commercial process for canning apples in the preservation of vitamin C. As a matter of fact, apples so canned in October and fed during the subsequent winter proved actually superior in vitamin C content to the raw apples from which they were taken and held meantime in cold storage. A further study of this fact led to the observation that apples during cold storage gradually lose their vitamin C content, perhaps to the extent of 25 per cent. within a few months. In canned foods the vitamin C is relatively stable within the entire period of distribution of any canned product. This stability of vitamin C in a can is really not surprising when it is borne in mind that vitamin C is particularly susceptible to oxidation and that in a can of food there exists a very strong reduction potential resulting from the high overvoltage that develops on tin.

Apples are rather porous and contain more intercellular oxygen than practically any other fruit or vegetable. Because of this, unless the oxygen is removed, destruction of vitamin C during any cooking process is very complete. The demonstration by the unique process described above, that apples can be canned without any vitamin C destruction, and that, after canning, vitamin C is relatively stable, paved the way for a comprehensive study of the vitamins in canned foods generally. Instead of the canning industry being challenged on the point of vitamin destruction in its commodities, it can now claim unhesitatingly a high degree of efficiency in vitamin conservation. Succulent vegetables and fruits, the original source of most of our vitamin supply, are the basis of the canning industry. Therefore, it can pride itself on supplying us with a continuous supply of vitamin-rich foods, as the following comparison indicates.

Peaches and pineapples constitute the two largest items of canned fruits. Both of them in canned form are richer in vitamins A, B, and C than raw apples, the fruit eaten in the largest quantity in the raw state, and are fully comparable to raw bananas. Citrus fruits are richer in vitamin C, but pineapples and peaches outstrip the citrus fruits in vitamin A to as great an extent. Although canned tomatoes are considered a vegetable product from the culinary viewpoint, botanically speaking the tomato is a fruit. Canned tomatoes are a better source of vitamins than the tomatoes picked immature for shipment out of season and allowed to ripen artificially. While oranges are only moderately more potent in vitamin C than tomatoes, the latter are several times as potent in vitamin A as oranges and equal to oranges in vitamin B content.

Head lettuce and celery stalks constitute the vegetables eaten in the raw state to the greatest extent. Canned peaches, pineapples, and tomatoes, as well as a number of the green canned vegetables, such as peas, asparagus, and so forth, are richer in vitamin A and C than head lettuce and celery stalks and many of them are richer in vitamin B also.

Chemistry in industry is generally thought of as concerned with the development of new products and new processes. In the above, no new process nor new product was developed. The chemical studies merely demonstrated what an industry is accomplishing in the light of more advanced chemical knowledge and information. The development of such knowledge is sometimes more valuable than the development of new processes, or new products.

XVII. TEACHING IN THE UNIVERSITY

JACK P. MONTGOMERY

In this article the writer portrays the duties of one teacher in university circles. Dr. Jack P. Montgomery is a professor in the Department of Chemistry, School of Chemistry, Metallurgy and Ceramics at the University of Alabama.

Mr. Montgomery attended Howard College, Southwestern Presbyterian University (now Southwestern in Memphis, Tennessee), and the University of Virginia. Later he studied at Johns Hopkins, Chicago, and Columbia. He holds the degrees of A.B., M.A., and Ph.D. He is an active member of the American Chemical Society and chairman of its committee on Pre-Medical Requirements.

Chemistry has been taught at the University of Alabama during the one hundred five years of its existence. The current class rolls now carry a total of more than one thousand in chemistry. Further description of the work of the department is contained in the article.

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In this department there are ten professors and instructors of faculty rank and about twenty-five student assistants. Although the Head of the Department is also Dean of the School of Chemistry, Metallurgy, and Ceramics, the majority of students registered in chemistry courses are from the Liberal Arts College and many of them are pre-medical students. With such a setup, it naturally follows that for each of us there are specific teaching duties, general departmental duties, special departmental assignments, and, for the more experienced, administrative tasks which may extend beyond the field of the department.

The ordinary teaching load at this University is fifteen hours a week, with two hours of laboratory instruction counted as equal to one hour of lecture or classroom work. This load, wherever possible, is somewhat reduced for those who have administrative duties. But if a teacher is to succeed in chemistry he cannot afford to count the hours credited to him by some standardizing agency. His hours of interesting endeavor will go far beyond the count.

In my own case the particular teaching job is the eight-semester-hour course in organic chemistry. Nearly two hundred students take this work and three-fourths of them are pre-medical students. They are divided into two lecture sections and five laboratory sections. One lecture section meets on Monday, Wednesday, and Friday and the other section on the alternate days. It is my endeavor to keep the two lecture sections quite close together, week by week, and to make the laboratory work illustrative of the subjects being discussed that week. This, of course, requires some watchfulness and organization, with considerable planning for the laboratory work. On Wednesdays I attend the meeting of the Kiwanis Club where I enjoy, among other things, a cup or two of excellent coffee and under the combined stimulating effects of the meeting and the coffee, Wednesday afternoons are spent in looking over the field for the work of the next week, delving into laboratory manuals, looking over old laboratory sheets, and preparing the material for one of the student assistants to mimeograph, our laboratory instructions being from mimeographed sheets issued each week rather than from the usual manual. This requires more effort, but the reward is in the constantly improving work done by the students.

Other courses which I handle, for small groups of advanced students, are those in physical organic chemistry and in the chemistry of cellulose, and then, somewhat as an avocation and to keep in touch with general chemistry, I have a very interesting group, mostly seniors, in the history of chemistry. Most of the students taking the latter course need an additional two hours for their major in chemistry and think that they want a general review, but they frequently get more than they anticipate.

Most of the research in organic chemistry and the work in qualitative and quantitative organic are handled by a younger professor and a good deal of my own office time is devoted to some of my organic students of the year before who drop in for information or reassurance. All of this keeps me pleasantly in contact with other phases of organic chemistry which I am not teaching. In addition, since so many of my students in organic are taking it as a direct preparation for physiological chemistry, it gives me an incentive to keep in touch with the physiological chemistry courses in various medical schools as well as in our own department.

Among my general departmental duties the chief one has been assembling the requisitions, seeking lowest prices, and ordering about twenty thousand dollar's worth of supplies each session, with the subsequent checking of accounts. The department is now so large that I no longer have this to do except for my own particular needs, but that is quite a job in itself. Another member of the department now does the bulk of this. An important duty of our only woman professor is the care of the library, the direction of her assistant, and the ordering of books. Still another member of the department handles the details of schedules and the assignment of rooms. Every member of the department has some such regular assignment, in addition to his classroom work, and these assignments, with the special ones constantly coming to hand, give him plenty of activity.

My chief administrative duty is connected with the pre-medical courses. The Pre-Medical Committee, of which I am Chairman, relieves the Dean of the Liberal Arts College of all details of curriculum, except as

affecting requirements for a degree, places students in various medical colleges, and generally advises pre-medical and pre-dental students. Fortunately, the pressure of such duties comes only at the beginning of each semester and for a brief period in February. Such work is really very delightful as it consists largely of guidance and advice, the disciplinary duties remaining in the hands of the Dean. Since our pre-medical group is the most cosmopolitan of any here, advising them brings many and varied experiences and confidences. Out of some of these has come the organization of the Alpha Epsilon Delta Pre-Medical Fraternity, which is now a national organization, and the Pre-Medical Club, a much larger local organization.

In connection with their teaching, other members of the department have advisory duties for various groups, chemical engineers, domestic science students, chemistry of commerce group, education students, and those of the different divisions of the School of Chemistry, Metallurgy, and Ceramics.

From the above it would appear that any of us could boast of a full day's work, but some of us are frequently called upon to attend evening functions of various student organizations, all the way from an informal smoker to a dignified appearance as principal speaker. The present writer must add to these various duties, committee meetings in connection with the Y. M. C. A. and in awarding scholarships and loan funds of groups which have made him one of the trustees.

Then connections with professional groups must not be forgotten. Membership in several learned societies carries obligations of more than mere financial support in the matter of dues. Serving on committees, as a contributing editor, or even as an officer in a local section calls for outlays of time, especially in writing letters.

To the prospective teacher of chemistry, looking to university work, I should say that he is likely to begin in a minor position and gradually work up to professorship and so is not likely to fall into a rut and remain in it unless he is very unfortunate in location or in temperament. What I have written describes my present activities, but time was when I taught four consecutive classes each day in general chemistry, and it seemed at times that I was in a tread mill. For almost every young teacher there will be this period of waiting and development, a time of apprenticeship coming between his graduate work and the beginning of his true fruition. Looking back on my own career, I should say that any success which I have had is due to a combination of circumstances including a long-standing desire to teach, the fine example of some excellent instructors, good training in the fundamental of science, ingrained desire to learn something of the progress being made by others, adaptability to experience under changing conditions, and a certain element of luck which has enabled me to appreciate more and more as I grow older the confidence which I have in young people and the regard which they seem to have for me.

[Dr. Montgomery gives the following advice to be considered by those who plan to teach.]

1. Get as thorough a foundation in the fundamentals of chemistry as possible and reinforce it by thorough study of as many other sciences as possible. Be able to differentiate the importances of experimental facts and theories, with sincere willingness to discard an outworn theory when it has become confusing or useless.
2. Graduate work is likely to make the student narrow. While in the graduate school read as much as possible along lines different from your research. Keep up, if you can, with the constant changes in general chemistry and look out for the development of the unorthodox in organic chemistry.
3. Become aware of the attitude of the professional educator. If possible take a course in the history of education.
4. By all means study your own teachers and learn what to emulate and what to avoid.
5. After you get into teaching do not shirk administrative work which will bring you into contact with your students and your colleagues.

XVIII. RESEARCH IN AN AGRICULTURAL EXPERIMENT STATION

CHARLES H. HUNT

The writer of this article, who is an Associate in the Department of Animal Industry, has been with the Ohio Agricultural Experiment Station since 1920. Dr. Hunt was graduated from the state college of Washington and has done graduate work at Columbia University and the Ohio State University. From the latter he received the Ph.D. degree in 1926.

He is a member of Phi Beta Kappa, Phi Kappa Phi, Sigma Xi, and the American Chemical Society. His research publications have dealt with mineral metabolism and vitamins.

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There are in the United States proper forty-eight main agricultural experiment stations, and in some states there are one or more substations. All of these stations are research institutions devoted to a study of the fundamental knowledge underlying agriculture.

The efforts to advance information and bring about improvement in agriculture recognize various grades of attempts. These range all the way from simple tests to original research. In this brief picture an attempt will be made to show some of the problems a research chemist in an agricultural experiment station is confronted with, followed by an outline of one or two specific problems under study.

Let us first develop a theory as to the purpose of agriculture. Dr. Fletcher, of England, makes the statement that the object of agriculture is the nutrition of man. Now, let's see whether the above statement is true and whether agriculture has fulfilled its commission. No one denies the fact that the United States as a whole produces sufficient food for our needs, but very often a deficiency exists in localized areas, due to soil and climatic conditions, and as a result some people may suffer for lack of food. Under some conditions and in certain localities, it seems that it is almost impossible to raise livestock, because of the failure of

THESE TWO RATS ARE LITTER MATES. THE ONE ON THE LEFT RECEIVED A COMPLETE DIET. THE DIET OF THE RAT ON THE RIGHT WAS DEFICIENT IN VITAMIN G

the forage to support normal growth and well-being of the animal. Crops grown on land that has been cropped for decades, without returning some of the fertilizer removed with the crops, are usually deficient in lime (calcium) and phosphorus, and some of the other elements, such as iodine, copper, and so forth. Research chemists in some of these experiment stations have found that where these elements are lacking, certain animal diseases are prevalent, and, in order to be successful in raising livestock in these areas, the missing mineral element must be added to the rations, or better, added to the soil as fertilizer. For example, cattle in certain areas, in Florida, develop salt sickness or anemia, due to a deficiency of iron and copper in the soil and, therefore, in the feed.

Cattle in certain sections of Montana, Minnesota, Wisconsin, Michigan, and other states develop depraved appetites, fail to thrive, and become sterile on account of insufficient phosphorus in the soil and in the feed. When the minerals, such as iron, copper, calcium, and phosphorus, which are deficient or absent in the soil and therefore in the feed are added to the ration of the animal, these diseases are cured and if added in time they are prevented. Thus, it can be said with a degree of certainty that the quality of plants and indirectly, as will be shown later, the food eaten depends upon the soil and the climate. The climate cannot be regulated but, to a partial extent, the deficiency of the soil can be overcome. It appears, then, that agriculture cannot fulfill its commission in certain localities at least unless the research chemist can come to the livestock industry and other agricultural interests in these localities and make it possible to support man. These very things have been done, much to the credit of the various experiment stations.

Now, since the writer is one of these chemists and being interested in animal nutrition, it becomes his task (with pleasure) to find out all he can about the plants that go to make up an animal feed and what effect these feeds have upon the animal and its by-products, such as eggs, milk, and so forth. The first problem was that of the vitamin G content of hays as they are affected by the stage of maturity when cut and by sunshine and rain. It has just occurred to the writer that he has not mentioned anything about the vitamins, but most people are vitamin conscious and need no introduction to them, except to say that they are absolutely essential for all animal life. One of the principal and one of the most important vitamin constituents of milk and eggs is vitamin G and the natural question that comes to mind is, can the vitamin G content of milk be increased by feeding? Here are two problems, and it naturally appears that the second is dependent upon the first. One may ask of what value is such an experiment? Do not hays and milk contain enough of this vitamin for all practical purposes? This is a natural question, but one must realize that research chemists are after all facts, irrespective of whether they are of a practical nature or a scientific curiosity.

What shall be the procedure? In addition to the laboratory with the usual chemicals and equipment one also uses white rats. Instead of weighing precipitates one weighs the animals. The animals are first standardized as to heredity and feeding, just as a buret would be standardized in the usual way in the laboratory.

The young from these animals, when twenty-four days of age and weighing about 50 grams, are placed in screened bottom cages (to prevent coprophage) and given a standardized diet that is free from the particular vitamin under study (in this case vitamin G), but complete in every other respect including protein, other vitamins, and so forth. They remain on the diet until the animals' store of vitamin G is all utilized in body function. Then, and only then, will the animal cease to grow. Next, they are placed in individual cages and fed hays that have been cut at different stages of maturity, subjected to sunshine and rain, and then ground to a fine powder. The way an animal responds in growth to the feeding of definite weights of these different sam-

ples determines the vitamin content of the particular sample. If the results are to be reported in units of vitamin G per gram of hay, one must feed that amount which will give an increase in weight of the animal of three or four grams per week and then calculate the units per gram.

The results of such a procedure show rather conclusively that the earlier the hay is cut—therefore a greater percentage of leaves to the total weight of the plant—the higher the vitamin content. Rain was found to remove a considerable amount (sometimes as high as 50 per cent.) of vitamin G. Therefore, any process or method that would lower the leaf content or remove the water-soluble vitamin G would lower the quality of the hay. Thus, a person has a method of measuring one of the factors that determines the quality and can recommend at what stage of maturity a hay should be cut to produce the highest quality. The study has given some practical results.

The next question that naturally arises and which has been previously mentioned is what effect will hays of low vitamin G content (low quality) have upon the vitamin G content of milk from cows eating such roughage. This can be determined by a similar method as that outlined for hay. However, in this case measured amounts of milk are fed to standardized and depleted rats and the increase in growth is measured in terms of volume of milk fed. Here again, one can obtain some very interesting as well as scientific data, which show that not all body functions are under physiological control and that the quality of milk can be influenced by the feed of the animal.

One may get the impression that such a determination is rather simple, and almost anyone would be capable of carrying on such an experiment. It does look easy, but such is not the case, unless one knows how, and even then it has required several years of training in the knowledge and technic of vitamin preparation as well as the methods and technic of vitamin feeding. One has to consult a voluminous amount of published work and experiment with the various methods so as to arrive at the most accurate one. The preparation of these vitamin fractions requires skill and patience. For example, vitamin B_1, which must be used in the above standardized diets, is generally prepared from rice polishings. This is done by making a 95 per cent. alcoholic extract of the polishings and then removing the alcohol by distilling in a partial vacuum. This is done to prevent the heat destruction of vitamin B_1 and to recover the alcohol. The remaining alcohol may be removed by evaporation before an electric fan. The mixture is then diluted with distilled water to the required concentration. Since rice polishings contain but very little vitamin G and also are very insoluble in 95 per cent. alcohol, the above preparation is practically free from food elements and vitamins, other than B_1. Some chemists treat the above vitamin B_1 preparation with a definite weight of fuller's earth. When the solution has an acid reaction of about pH 4.0 the vitamin B_1 is best adsorbed by the earth. The non-adsorbed fraction, including proteins, minerals, and other vitamins, is removed by filtration. The activated or residual fuller's earth thus prepared is fed directly as a source of vitamin B_1 in the diet.

Here is a field that can satisfy the most imaginative person. There are problems involved in the field of nutrition of animals and plants that no one has even touched.

XIX. THE CHEMIST IN THE GLASS INDUSTRY

S. R. SCHOLES

The writer of this article is well qualified by training and experience to discuss the work of the chemist in the glass industry. Dr. S. R. Scholes was granted the A.B. degree by Ripon College and the Ph.D. degree by Yale. He was the Loomis Fellow in Yale for one year and a fellow in the University of Pittsburgh for two years after he had received his Ph.D.

He has been connected with the H. C. Fry Glass Company, the Utility Glass Company, The Federal Glass Company, The Fostoria Glass Company, and since 1932 has been Glass Technologist at the New York State College of Ceramics. He was Assistant Director of Mellon Institute for three years.

He is a member of the American Chemical Society and a fellow of the Ceramic Society. He is the author of a number of publications.

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In this discussion of the work carried out by the chemist, we are assuming that he is the only technical man employed by a plant of moderate size, that is, he is responsible for whatever work of a scientific nature being done.

He analyzes the raw materials, as often as that may be necessary, to insure that the glassmaker has a definite knowledge of these materials as to composition and especially as to impurities. He analyzes the glasses, which are the product of the plant, often enough to check the

performance of the mixing department and to insure that the composition of the finished glasses is kept within the desired limits. He may also analyze other glasses for the purpose of keeping in touch with what other factories are producing or for the frank purpose of duplicating glasses made elsewhere that may seem more suitable for his plant than the formulas already at hand.

A number of accessory materials used about the plant must also occasionally be tested, qualitatively and quantitatively. Some of these are materials used in the decorating of glassware; for example, colorants and acids for etching. The boiler water may require careful checking to make sure that the water softener is behaving properly. Various commercial cleaners used in different parts of the plant may need analysis and, finally, there is the important matter of fuels and flue gases. By making periodical analyses, the chemist is able to check the behavior of the furnaces and to estimate their heat-balance and fuel economy.

A number of tests of the product, not of analytical nature, must be occasionally carried out, and these, whether physical or chemical, are commonly performed by the chemist. One of these is resistance to thermal shock, which is especially desirable in a bottle or tableware factory. A number of pieces of glass are tested by alternate immersion in hot and cold water and the difference of temperature which they will sustain without breaking is a measure of their thermal endurance.

The solubility or durability of the glass, although this cannot in general be predicted from the composition, must often be rechecked in order to satisfy the requirements of some new customer or to make possible a sort of umpire's decision in the event of complaints. The general physical properties of the glass are tested, especially, with a view to their improvement by alterations in the chemical composition. One of these physical properties, the density or specific gravity, is a convenient laboratory determination that serves to give assurance that the composition of the glass is remaining constant. Another, the determination of softening temperature by an empirical method, performs a similar function. In a few establishments, the optical properties of the glass become important and, nearly everywhere, the control of color, whether in ware which is actually colored, or in crystal. It is the particular duty of the chemist to take a complete set of samples of ware daily and to inspect these for regularity of color. He then specifies what slight changes must be made in the colorants or decolorizers employed to maintain proper standards.

The synthetic work of the chemist involves, principally, the compounding of glasses whenever new types are desired, or when improvements must be made to better the physical properties of glasses already in use. He may also be required, occasionally, to develop a color not hitherto made in the factory. In work of this sort, he proceeds first from a theoretical point of view to plan from published data, supplemented by his own experience, suitable compositions. He then makes experimental meltings, especially in color work, to test his estimates on a small scale. These meltings may be in crucibles of a pound or two, or he may ask for the loan of a single pot in the main furnace and boldly experiment with a half-ton or more.

The chemist is also required to act in an advisory capacity to other members of the factory staff. From his general knowledge of chemicals and of the nature of materials of one sort and another, and also from his acquaintance with technical firms and their advertising, he is in a good position to be of assistance to the purchasing agent of the company on many occasions. When new materials are required, or when salesmen call and present competitive products, it is often the chemist who must be called in to help decide on purchases. He is often consulted when new developments are projected or when calculations must be made for new furnaces, new equipment of various sorts, annual budgets of materials, and the like. He can also be of great assistance to the cost accounting department because of his familiarity with the quantities of raw materials used, especially in the actual glass. He can also estimate the various losses and shrinkages and thus enable the cost accountant to arrive at more accurate figures for the cost of the melted glass as delivered to the workmen or the machines.

Thus far, these duties of the chemist, as outlined, have pictured him as a member of the staff rather than as one of the line organization; that is to say, his general duties are of an advisory, controlling character rather than of a routine sort, concerned directly with the daily production. In general, he becomes well acquainted with all of the operating departments and, while he is without direct authority, perhaps in any of these, he is very useful in suggesting to superintendents and managers changes and improvements which will increase or better the production.

It will be understood that the picture we have drawn here is of a man who must occupy a position of rather broad, scientific responsibilities. In a somewhat larger plant, he will have assistants and each of these will specialize in only a few of the above duties. In still larger organizations, the scientific work may be subdivided still further into organized departments under a general director of development and research, under whom will be laboratories of chemistry, physics, and engineering. But this last condition exists only in a very few establishments. For the most part, the chemist is practically alone in his work when he is a member of the staff of a glass company of the average size.

[Dr. Scholes's rating and discussion of the personal characteristics are interesting and helpful.]

"Those personal characteristics which are most desirable in a chemist who is to become successful in industrial work must necessarily be matters of opinion. But I would rate them somewhat in the following order: (1) honesty, (2) industry, (3) ability to coöperate, (4) judgment, (5) scientific attitude, (6) adaptability, and (7) skill, or dexterity. To analyze some of these briefly we may say first that unless a chemist is completely honest, he will end by deceiving not only others, but himself; his results will be entirely without value, and

he can hope for no advancement whatever. He must be willing to work hard and to find suitable tasks. Very often, no one else in the establishment can tell him what to do, but he must possess the initiative, which we are here placing as one of the attributes of industry, to put himself to work. If he cannot coöperate with other people, or if he feels that his education makes him somewhat superior to the run-of-the-mill men, he will not be able to get coöperation and, therefore, will fail to get results. He must work hard at all times to develop in himself judgment, to be able to estimate comparative values, especially of scientific data. By the scientific mind we mean the mind which tries to find out the facts, rather than merely those facts which will support a previously formed judgment. The chemist must be sufficiently adaptable so that he does not regard himself as a narrow specialist who can work only with burner and crucible and balance, but who can apply his scientific training anywhere in the plant. Finally, the more neatness, precision, dexterity, and manual skill he develops in all lines, the more thoroughly useful he may become."

The EFFECT *of* HIGH-SCHOOL CHEMISTRY *on* ACHIEVEMENT *in* BEGINNING COLLEGE CHEMISTRY

PAUL E. CLARK

Muskingum College, New Concord, Ohio

In the experiment reported in this paper an answer is sought to the question: "How does high-school chemistry affect achievement in beginning chemistry at Muskingum College?" The experimental method is used; that is, an attempt is made to control other important factors in chemistry achievement so that the true effects of high-school chemistry can be ascertained.

The results indicate that at least for the first semester of the school years 1935–36 and 1936–37, high-school chemistry was an important determiner of success in first-year college chemistry as determined by percentiles made on an objective achievement test. The results have affected chemistry sectioning practice at Muskingum and have suggested some other investigations which should be made.

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THE question as to whether a course in high-school chemistry helps the student to accomplish more in college chemistry has long been debated. The answer to this question is important, for on it depend such things as proper advisement of high-school students who expect to go to college and the placement of college chemistry students in proper sections. Many attempts have been made to answer this question in the last decade. Most of the studies reported in the literature show that high-school chemistry helps to improve the students' chances for success in beginning college chemistry. Some of these studies, however, have not been carried out with sufficiently well-controlled conditions to enable the experimenters to arrive at valid conclusions. Furthermore, the effect of high-school training in chemistry may vary somewhat from college to college, depending on such things as methods of sectioning first-year chemistry students, methods of teaching, and the basis on which achievement is judged.

One noteworthy attempt to gain a partial answer to the question was made by Noll in connection with his study at the University of Minnesota.[1] In this particular section of the study he used two matched groups of sixteen men each. The pairings were made on the bases of percentile ranks in the Minnesota Ability Test and scores on the "Iowa Placement Examination," Series C, A_1, Revised A. The members of one group had had high-school chemistry, while the members of the other group had not. Both groups had practically identical chemistry courses at the University of Minnesota. The scores made on his "Test of Chemistry

[1] NOLL, V. H., "Laboratory instruction in the field of inorganic chemistry," University of Minnesota Press, Minneapolis, Minnesota, 1930, pp. 104–7.

Achievement" were taken as the criteria of success. He found, as would be expected, that the group having had chemistry in high school showed a very significant superiority on the initial achievement test when it was given on the first day. He also found that, using the same test, only a small difference existed between the groups after two quarters of instruction. Many chemistry teachers would expect a significant difference between the groups even after two quarters of college chemistry. The results he shows are interesting, but the author himself points out the danger of generalizing from his data because different situations, different technics, and different criteria of success might produce different results.

For the last four years the Committee on Tests of the American Association of Physics Teachers has been collecting some interesting data from a large number of coöperating colleges and universities. The long-range program set up by this committee is an elaborate one. Its investigations pertain primarily to physics, but some of the results are suggestive to chemistry teachers as well. Some conclusions with regard to the effect of high-school physics on achievement in college physics are given in the third annual report.[2] It was found that, except in the first semester topics, those students who had high-school training in physics did but little better on an objective pre-test than those who had no such training. At the end of the year, however, those students who had had physics before were greatly superior on the post-test.

More recently the writer completed and published a study of the situation at Muskingum College.[3] The results show that a course in high-school chemistry improved the freshmen's chances for success in the more elementary of the two first-year courses. The study involved the freshmen who took beginning chemistry (Chemistry 111) during the first semester of the school years 1932–33, 1933–34, and 1934–35. In this study an attempt was made to control important determiners of student success other than high-school chemistry. To do this, it was decided to develop a regression equation for the group (Group A) which had no high-school chemistry. Many factors probably help to determine success in chemistry, and it was seen at once that it would be impossible to include all such factors in the predictive equation. Several preliminary studies were made to try to determine the most important of these factors, and the investigations indicated that some measure of intelligence and some measure of the students' work habits were likely the most significant of these variables. Thus, the regression equation was based on: Ohio State University Psychological Examination percentile, six-weeks' grade-point ratio in all courses, and the six-weeks' grade in chemistry. The latter two terms were intended to show the students' work habits. This equation was then used to predict the students' final semester grades in chemistry. The grades the students actually received in chemistry at the end of the semester were taken as the criteria of success. Predictions of final grades were also made from this same equation for those who had had high-school chemistry (Group B). Fifty-four members of Group A were then paired with fifty-four members of Group B, the two members of each pair having the same predicted grade. When this was done, and the means of each group of fifty-four compared, it was found that there was a statistically significant difference in favor of the group having had high-school chemistry. Since all members of both groups had the same chemistry course at Muskingum, and since the members of Group B were supposed to have the same chances of making a certain grade as the corresponding members of Group A except for the fact of their having had high-school chemistry, it is believed that the members of Group B made their better showing because of having had such a course.

It is the purpose of this paper to report a similar study on freshmen and sophomores taking beginning chemistry at Muskingum during the first semester of the school years 1935–36 and 1936–37. The same methods were used as are reported above, except for some changes in the factors used in developing the regression equation. At the time that the previous study was made, the writer felt that final eighteen-weeks' grades were not satisfactory criteria of student success, partly because of the grossness of the measure. That is, the letters A, B, C, D, and E were used as issued by the instructor, except that the corresponding integers 4, 3, 2, 1, and 0 were substituted for them in making calculations. Thus it was felt that many fine variations in student behavior might not be shown by this rough sort of measure. It was thought that improvement on a chemistry achievement test might better be used instead of grades. However, when the previous study was started such information was not available.

For the last two years, the instructors in the chemistry department have been giving several objective tests in chemistry to the first-year students. These tests are given in addition to the regular testing program which is used for the determination of grades. They are: a chemistry aptitude test at the beginning of the first semester, a chemistry training test at the beginning of the first semester, and the latter test repeated at the end of the semester.

All tests given were those developed by Cornog and others at the University of Iowa. In the year 1935–36, the chemistry aptitude test used was "Iowa Placement Examination," New Series, C.A., Form X (1930), and the chemistry training test was "Iowa Placement Examination," New Series C.T., Form X (1930). In the year 1936–37, the aptitude test was "Iowa Placement Examination," C.A., Revised A (1925) and the training test was "Iowa Placement Examination," Series $C.T._1$, Revised A (1925). Since different tests were

[2] COMMITTEE ON TESTS OF THE AMERICAN ASSOCIATION OF PHYSICS TEACHERS, "The 1935–36 college physics testing program," Supplement to *The American Physics Teacher*, **4**, 153–66 (Sept., 1936).

[3] MUSKINGUM COLLEGE FACULTY, "A college looks at its program," The Spahr and Glenn Company, Columbus, Ohio, **1937**, pp. 57–64.

given in the two different years, the raw scores could not be used, for scores on the different series are not comparable. To get around this difficulty, the raw scores were all transmuted into percentiles so that the ratings for the two years could be combined. In calculating percentiles, the norms used were those developed by the Bureau of Educational Research and Service of the Extension Division of the University of Iowa. In this study, the first chemistry training test served as a pre-test, while the second time it was given it served as an end-test. The percentiles made on the end-test were used as the criteria of student achievement. The factors used in developing a predictive equation were: percentiles made on the pre-test (X_2), percentiles made on chemistry aptitude test (X_3), and the percentiles on the Ohio State University Psychological Examination (X_4).

The regression equation developed for control group A (those who had no high-school chemistry) was:

$$X_1 = 0.357\,X_2 + 0.183\,X_3 + 0.373\,X_4 + 2.49$$

By means of this equation, then, it was possible to predict with a fair degree of accuracy the percentiles which the members of the control group would make on the end-test (X_1). For all forty-nine members of this group the multiple correlation coefficient, $R_{1\cdot234}$, was found to be 0.70, as was also the zero-order correlation coefficient between predicted and achieved percentiles.

This equation was then applied to the thirty-nine members of experimental group B (those who had high-school chemistry) and their end-test percentiles predicted. Thirty members of Group B were then paired with thirty members of Group A. The two members of any given pair had about the same predicted end-test percentile.* All further comparisons were made, then, on the showings of the thirty paired members of each group. The correlation coefficient between predicted and achieved end-test percentiles for those thirty paired members of Group A was found to be 0.73 (r_A), and the coefficient for those paired members of Group B was found to be 0.79 (r_B). The chief results of the pairings are shown in Table 1.

This table shows that, although the predicted mean percentiles for the two groups are about the same, the group that had high-school chemistry *actually* averages considerably more than the other group. Presumably, the two members of any given pair had equal chances to make a certain percentile on the end-test except for the influencing factor of high-school background in chemistry. This means, then, that if the factors used in the predictive equation are satisfactory, any difference in the means achieved by the members of the two groups can likely be attributed to the effect of high-school chemistry. As can be seen from Column 4, Table 1, there is a difference between the means achieved by the members of the two groups, and this difference is statistically significant in favor of those who had high-school chemistry.

TABLE 1

COMPARISON OF MATCHED GROUPS AS TO MEANS AND STANDARD DEVIATIONS OF END-TEST PERCENTILES

Group (1)	Number of Cases (2)	Mean Percentile and Standard Error* of Mean: Predicted (3)	Mean Percentile and Standard Error* of Mean: Achieved (4)	Standard Deviation and Standard Error† of Standard Deviation: Predicted (5)	Standard Deviation and Standard Error† of Standard Deviation: Achieved (6)
B (took high-school chem.)	30	45.2 ± 3.00	52.8 ± 4.86	16.5 ± 2.13	26.7 ± 3.44
A (took no high-school chem.)	30	44.8 ± 2.97	42.8 ± 5.03	16.3 ± 2.10	27.6 ± 3.55
Difference‡		0.4 ± 2.20	10.0 ± 3.64	0.2 ± 1.56	−0.9 ± 2.57

* $\text{S.E.}_M = \frac{\sigma}{\sqrt{N}}$

† $\text{S.E.} = \frac{\sigma}{\sqrt{2N}}$

‡ The formula used to obtain the standard error of a difference between the means and between the standard deviations is:

$$\sqrt{\text{S.E.}_A^2 + \text{S.E.}_B^2 - 2\,r_A\text{S.E.}_A\,\text{S.E.}_B}$$

where S.E._A and S.E._B are the standard errors of the measures A and B, respectively, and r_A is the correlation coefficient between predicted and achieved percentiles for the thirty paired members of the control group; *i. e.*, 0.73.

This difference is exactly ten percentile, and this probably can be interpreted as meaning that the paired members of Group B made approximately ten percentile more on the end-test than they would if they had not had high-school chemistry. The paired members of control group A, on the average, showed a gain of about twenty percentile (the gain is found for any given student by subtracting his pre-test percentile from his end-test percentile) during the semester.† The mean difference between the two groups at the end of the semester is then about equivalent to the average gain made by members of the control group in one-half a semester if this progress is assumed to be distributed evenly. This shows that, within the limitations of the experimental method employed and in so far as the chemistry training test used measures desirable achievement in beginning college chemistry, the paired members of the experimental group really accomplished a great deal more because of having had high-school chemistry.

The results shown in Table 1 are valid only if the important determiners of achievement on the end-test were taken into proper consideration when the regression equation was developed. In order to determine this, pairings were again made using first just the members of Group B and then again using just the members of Group A. That is, two subgroups for B and two subgroups for A were formed. If no significant differences can be found between the two subgroups of a given group, it can be concluded that most of the important determiners of achievement in chemistry, as measured by the test used, were taken into consideration, either directly or indirectly, when the regression

* The maximum difference between members of pairs in terms of the predicted percentiles was four, or about one-fourth of the standard deviation, and members of fourteen of the thirty pairs had exactly the same predicted percentile.

† This figure is not shown in the tables but is supported by data in the author's possession.

equation was developed. That such is the case can be observed from Table 2.

TABLE 2

COMPARISON OF SUBGROUPS AS TO MEANS AND STANDARD DEVIATIONS OF END-TEST PERCENTILES*

Group (1)	Number of Cases (2)	Mean Percentile and Standard Error† of Mean: Predicted (3)	Mean Percentile and Standard Error† of Mean: Achieved (4)	Standard Deviation and Standard Error‡ of Standard Deviation: Predicted (5)	Standard Deviation and Standard Error‡ of Standard Deviation: Achieved (6)
B_1 (took high-school	14	44.0 ±4.05	52.9 ±7.35	15.2 ±2.86	27.5 ±5.20
B_2 chem.)	14	43.6 ±4.41	50.4 ±6.95	16.5 ±3.12	26.0 ±4.91
Difference**		0.4 ±2.76	2.5 ±4.49	−1.3 ±1.95	1.5 ±3.29
A_1 (took no high-school	15	44.2 ±3.87	42.8 ±6.87	15.0 ±2.74	26.6 ±4.85
A_2 chem.)	15	45.5 ±4.52	42.8 ±7.35	17.5 ±3.20	28.5 ±5.19
Difference**		−1.3 ±3.14	00.0 ±5.24	−2.5 ±2.22	−1.9 ±3.70

* Maximum difference between members of pairs in terms of predicted percentiles was one-third of the predicted standard deviation in each group.

† $\text{S.E.}_M = \frac{\sigma}{\sqrt{N}}$

‡ $\text{S.E.} = \frac{\sigma}{\sqrt{2N}}$

** The formula used to obtain the standard error of a difference between the means and between the standard deviations is:

$$\sqrt{\text{S.E.}^2_{A_1} + \text{S.E.}^2_{A_2} - 2r_A \,\text{S.E.}_{A_1}\,\text{S.E.}_{A_2}}$$

where S.E. represents standard error, and r_A is the correlation coefficient between predicted and achieved percentiles; a corresponding formula was used for Group B.

As can be seen from an inspection of this table no significant differences develop when the means and the standard deviations of either set of subgroups are compared. This helps to prove the validity of the results shown in Table 1; that is, high-school chemistry has been an important determiner of achievement in beginning chemistry at Muskingum College for the first semester of the last two years. These results also agree well with those obtained in the previously reported experiment, although in this study percentiles made on an achievement test were used instead of grades as the criteria of success or achievement.

The results of this study, as well as that one previously referred to, have affected practice at Muskingum and have suggested other experiments to the writer. First, they have been of assistance in attempts to section students taking first-year college chemistry. Two first-year courses have always been given: Chemistry 111–12 and Chemistry 121–22. The former is especially designed for those who have had no previous training in the subject, while the latter is more advanced and is for those students who have had a year of high-school chemistry. Many colleges do not section students in this way and there had been some questioning of the practice at Muskingum. However, since those who have had high-school chemistry (other things being equal) seem to do so much better than those without such a course, it would seem desirable to continue giving the two separate courses.

Previous to this year, many students with high-school chemistry were permitted, upon their petitions, to enroll in the more elementary course, so that the line of division was not sharp. Although this procedure certainly was not a very scientific one, it made these investigations possible by furnishing two groups of students (some with and some without high-school chemistry), all of whom had had the same college chemistry course. Now, chemistry students with high-school credit in the subject are required to enroll for Chemistry 121 and all others are put into the more elementary course. However, classes and laboratories in Chemistry 111 are scheduled at exactly the same hours as those in Chemistry 121 and some students are transferred early in the year from the latter course to the former. This arrangement is made because *some* students who have had high-school chemistry are not capable of doing the work in the more advanced course. Transfers are not made upon the students' applications as formerly, but solely upon the basis of their scores in the aptitude and training tests given at the beginning of the year. That is, those with high-school chemistry who score in the lowest third in these two tests are permitted to take the elementary course. Thus, the method of sectioning students with a view toward intellectual homogeneity has been put on a sounder basis.

Second, two other problems have been suggested to the writer. The first problem is, what is the effect of the *course* which the student takes in college on achievement in chemistry? Some teachers feel that when students with high-school chemistry take a course designed for those who have not had the subject they cannot be expected to do their best work. For instance, Glasoe found that there is some knowledge carried over from high-school chemistry to the first-year college course, and recommends that students submitting high-school chemistry for entrance be given a more advanced course in order to use this knowledge to the best advantage.[4] Unless this is done such students may become bored early in the year by certain repetitions in the more elementary phases of the work. If this is true, the differences between the two groups probably should be even greater than this paper shows them to be, for all of the students involved were thrown together in the more elementary course. A projected study, then, is to compare two matched groups of students all of whom have had high-school chemistry, but half of whom took the elementary course at Muskingum and the other half the more advanced course. Next, it should be noted that the differences shown refer only to those existing at the end of the first semester. Such differences may partly disappear as the second semester progresses. In the sophomore year at Muskingum chemistry students take the same second-year course regardless of which first-year course they had. Judging very roughly by grades, it does not seem to make any

[4] GLASOE, P. M., "Residue of high-school knowledge utilizable in college chemistry," J. CHEM. EDUC., **10**, 571–4 (Sept., 1933).

difference in their success in the second-year course which freshman course they had. Thus, another study is suggested: to collect data to try to determine if these differences do tend to disappear toward the end of the first year.

As this study is reported the writer recognizes that probably it will not solve many problems for other chemistry teachers. It certainly has not solved all of the writer's teaching problems, but it has helped, especially by indicating some lines along which additional research may be fruitful. The results are drawn from but one college and bear the limitations of the experimental method employed, the students involved, and the test used to measure chemistry achievement. The conclusions may not apply to any other college. It does, however, seem to give pretty satisfactory evidence for supposing that for the first semester of the last two years high-school chemistry has contributed much toward achievement in beginning chemistry at Muskingum. It is the writer's hope that it may prove *suggestive* to other college teachers who are curious about similar teaching problems.

CORRESPONDENCE

LE CHATELIER AND THE SYNTHESIS OF AMMONIA

To the Editor

DEAR SIR:

In the excellent article by Professor Silverman on Henry Le Chatelier in the December issue of THIS JOURNAL, there is one statement to which I must take exception. On page 556 we read, "It is not strange that he [Le Chatelier] should have accomplished the synthesis of ammonia from the elements in 1901, anticipating Fritz Haber, who is usually the only one mentioned in connection with the process." Now Le Chatelier himself in his last book "De la Méthode dans les Sciences Expérimentales," published in 1936, devotes three pages (pp. 73–6) to this synthesis in which he says that he tried to accomplish the direct union of hydrogen and nitrogen under a pressure of 200 atm. at a temperature of 600° in the presence of metallic iron. A terrific explosion occurred which nearly killed an assistant. Some time later Le Chatelier found that the explosion was due to the presence of air in the apparatus used. And thus it was left for Haber to succeed where a number of noted French chemists, including Thénard, Sainte Claire Deville and even Berthelot had failed. At the end of his career Le Chatelier, with a disarming frankness, tells us, "I let the discovery of the ammonia synthesis slip through my hands. It was the greatest blunder of my scientific career. I should have realized this synthesis five years before Haber. . . . ."

In calling attention to this statement I may say that those of your readers who are familiar with French will find a great many interesting observations and reflections in this scientific testament of a great Frenchman.

H. S. VAN KLOOSTER

RENSSELAER POLYTECHNIC INSTITUTE
TROY NEW YORK

To the Editor

DEAR SIR:

Your letter . . . and a copy of Dr. van Klooster's letter . . . with comments on Le Chatelier's synthesis of ammonia have been received. It is regrettable that I should have overlooked the material which Dr. van Klooster quoted from Le Chatelier's last book, "De la Méthode dans les Sciences Expérimentales."

I based my statement on earlier articles which Le Chatelier had published on the synthesis. The earlier impressions are corroborated in an article, "The Scientific Career of Henry Louis Le Chatelier," by Ralph E. Oesper, which appeared in the JOURNAL OF CHEMICAL EDUCATION, **8**, 442–61 (1931). On page 458 Dr. Oesper states, "At this period [the beginning of the World War of 1914] Claude was trying to develop the industrial synthesis of ammonia. He was guided to a large extent by the computations made by Le Chatelier, who had, in fact, taken out a patent long before Nernst and Haber had made their experiments. Claude's efforts met with complete failure, and he came for criticism and advice to Le Chatelier. The latter made certain suggestions, and Claude, then, for the first time, had the pleasure of seeing liquid ammonia issuing from his apparatus."

ALEXANDER SILVERMAN

UNIVERSITY OF PITTSBURGH
PITTSBURGH, PENNSYLVANIA

To the Editor

DEAR SIR:

With other material which you are publishing as notes concerning Henry Le Chatelier, I suggest that you make reference to his middle name. In a letter

which Ralph E. Oesper of the University of Cincinnati has just sent to me and which he received under date of December 13, 1930, from Professor Le Chatelier, the latter states, "Je m'appelle Henry Louis Le Chatelier."

My reasons for stating that he did not have a middle name were:

1. His signature;
2. The lack of a middle name in his published articles;
3. The lack of a middle name on the official announcement of his death by his family;
4. The statement of his son, François, that his name was Henry and not Henry Louis.

ALEXANDER SILVERMAN

UNIVERSITY OF PITTSBURGH
PITTSBURGH, PENNSYLVANIA

ISOTOPES AND ANALYTICAL STANDARDS

To the Editor

DEAR SIR:

The discovery of many isotopes of the chemical elements has greatly increased the number of known atomic species. Probably the list is not yet complete, although at present there are over two hundred fifty known. In spite of their number, isotopes have not affected appreciably the practical problems of the industrial analyst, since in nearly all cases the naturally occurring mixture for a given element seems to have a practically constant composition. The outstanding exception is lead, as it occurs in certain minerals. Baxter found that the element in one type has an atomic weight of 206 while that in another is 208. In these cases the use of the accepted value for ordinary lead (207.21) would lead to appreciable error in calculations. Also, evidence is accumulating that water from different sources may not have quite the same isotopic composition.

While the analytical problem presented by isotopes still seems industrially unimportant, developments have reached the point that, in the interest of accuracy of statement, several fundamental definitions in freshman and analytical texts need revision. Of special importance is the discovery of three isotopes each of hydrogen and oxygen, the respective atomic weights being close to 1, 2, and 3, and 16, 17, and 18. The object of this note is to direct attention to the analytical significance of these values with respect to atomic weights, equivalent weights, and the liter.

Calculations involving masses of the elements are related ultimately to the value 16.0000, chosen arbitrarily as the atomic weight of oxygen. In most texts it is not specified that this value refers to the naturally occurring mixture of oxygen isotopes. If the proportion of the three species, 0^{16}, 0^{17}, and 0^{18}, is known in the mixture, the atomic weights could be recalculated in terms of the lightest isotope. Since it predominates so largely in the mixture, the difference is not practically significant. However, the definition should be revised to conform to present practice.

Equivalent weights present a similar situation. According to the common definition, an equivalent weight is the mass chemically equivalent to 8.0000 g. of oxygen or 1.00 g. of hydrogen. Again, it should be indicated that these values refer to the commonly occurring mixture of the respective isotopes.

In the definition of the liter the analyst also confronts the problem of isotopes. This standard of volume is related to the kilogram in being defined as the volume occupied by a mass of one kilogram of "pure" water at the temperature of maximum density and under normal atmospheric pressure. With three isotopes each of hydrogen and oxygen, it is obvious that the designation of "pure" water is not an adequate specification. The practical difficulties involved in securing water consisting of one isotope each of hydrogen and oxygen seem to preclude this possibility. Even though water from different sources shows slightly different densities, the only feasible procedure at present for calibrating volumetric ware is to use ordinary water carefully purified. The definition should then be changed to indicate that the liquid specified is composed of the naturally occurring mixture of the isotopes of the two elements.

M. G. MELLON

PURDUE UNIVERSITY
LAFAYETTE, INDIANA

SOAP BUBBLES

To the Editor

DEAR SIR:

Apropos of the article "Tough Soap Films and Bubbles," by G. A. Cook, which appeared on pages 161–6 of the April JOURNAL OF CHEMICAL EDUCATION, I wish to say that I have found that a solution of "Dreft" (a Procter and Gamble household product) carelessly made with either hard or soft water can be used with "raw" hydrogen directly from the generator to blow bubbles that can be successfully cut off and allowed to rise. It might be of interest to our readers to know this, and perhaps the author of the paper referred to might care to apply his tests to standardized solutions of "Dreft," or to even more concentrated forms of high molecular weight half-esters such as that used in "Dreft."

FRANK B. WADE

SHORTRIDGE HIGH SCHOOL
INDIANAPOLIS, INDIANA

"ELECTROPOSITIVITY" AND "ELECTRONEGATIVITY"

To the Editor

DEAR SIR:

Since I read in the JOURNAL OF CHEMICAL EDUCATION an article of John DeVries entitled "Valence and Molecular Structure,"[1] in which mention was made of "The Electron Theory of Valence," by Rodebush, published in *Chemical Reviews* about seven years ago, I do not remember having read any other article, by way of comment, referring to the part of Rodebush's article cited by DeVries, which says,

"This is contrary to the current usage in inorganic chemistry where chlorine is usually termed negative or electronegative; but the current usage arose before the discovery of the electron and there seems to be no good reason for adhering to an illogical terminology."

In fact, to apply to atoms the peculiar behavior of their ions is improper and the earlier the correction is made, the better it will be. Of course, one of the difficulties, perhaps the most serious difficulty, is the fact mentioned by DeVries that the suggestion will be conducive to confusion, for according to DeVries "we have always regarded elements such as chlorine, for example, negative . . ." Besides I do not remember having read in books of chemistry of recent edition the use of the words electropositive and electronegative applied to non-metals and metals, respectively, in accordance with Rodebush's suggestion. On the contrary, all the older chemistry books and the ones of recent edition which I have read use the old terminology. It is true that it is possible to make the student use the new terminology after he has advanced in his studies, but especially in the beginning of his study, what terminology should the professor use?

The new definition of acids and bases also mentioned in the article cited, in accordance with the electron theory, has been accepted apparently without difficulty, for it does not completely change the old definitions and the new one is based on proved facts and accepted theories.

With all consideration and due respect to the authority of the advocate of the new terminology, let us examine the possibility of calling metals electro-negatives and non-metals electro-positives.

Calling non-metals electro-positives is undoubtedly proper and indisputable if we consider the fact that atoms of non-metals have the tendency to acquire additional electrons, and those that have a tendency to unite with negative units are by nature necessarily positive. An identical consideration may, however, not be applied to metals, for if the atoms of metals are electro-negative they should repel electrons of other atoms, or of any other source except their own. If the repulsion is due to the kernel, or the atom deprived of its valence electrons, which is the same ion, we shall fall into the same defect of the old terminology—attributing to an atom the property or behavior of its ion. Besides, atoms of metals have the tendency of acquiring their lost electrons, as that which happens in reduction reactions and in electrolysis.

Without authority, or sufficient competence in the matter, I venture to suggest another terminology. This will be nothing new or original. Any name suggested and accepted should not only be justified by and based upon facts and accepted theories, but such a name should already be in the minds of those absorbed in the subject, and the advocate has really done nothing but to express what they have been struggling to manifest.

We know that atoms have opposing tendencies in accordance with their nature: some have the tendency to lose or donate their valence electrons—the metals; and others to acquire or accept electrons from other atoms—the non-metals. If this is so, why don't we call metals electron donors and non-metals electron acceptors? If we have proton donors and proton acceptors, which terminology applied to acids and bases has already found general acceptance even if it is known that in reactions between two or more atoms, protons are not acquired or lost, why should we not have electron donors and electron receptors, knowing that in many reactions electrons pass from one atom to another? If, instead of using the names proton donors and proton acceptors for acids and bases, we have classified acids into true acids and bases according to the degree of their ionization, undoubtedly the terminology would have led to such confusion as arises from calling non-metals electro-positive and metals electro-negatives.

The suggested terminology should not be taken literally like other terminologies—they should be understood as referring only to the tendency of atoms, for we know that there are many atoms, which, in accordance with their position in the Periodic Table, have the tendency to acquire additional electrons, but in certain reactions with atoms that supersede them in this tendency, lose their own electron instead of acquiring additional electrons.

The suggested new names, like proton donors and proton acceptors, are not contradictory to the old and accepted terminology, for they only express confirmed facts in accordance with generally accepted theories.

FILEMON TANCHOCO

MANILA COLLEGE OF PHARMACY AND DENTISTRY
MANILA, P. I.

[1] DEVRIES, JOHN, "Valence and molecular structure," J. CHEM. EDUC., **13**, 320–4 (1936).

ATOMIC WEIGHT AND SYMBOL CHART

To the Editor

DEAR SIR:

I am enclosing a page containing a chart we have been using in teaching beginning chemistry which has been quite helpful to students learning to write formulas for acids, bases, and salts.

The use of type acids for each group of the periodic table enables the student to familiarize himself with the *ortho*, *meta*, and *pyro* acids, and to develop the ability to write formulas for salts. . . . .

ATOMIC WEIGHTS AND SYMBOLS

At. No.	*Group*	*Element*	*Sym.*	*At. Wt.*	*Valence*
89	3	Actinium	Ac	227.7	3
85	7	Alabamine	Ab	221.0	1,5,7,−1
13	3	Aluminum	Al	26.97	3
51	5	Antimony	Sb	121.76	1,3,5,−3
18	8	Argon	A	39.94	0
33	5	Arsenic	As	74.91	1,3,5,−3
56	2	Barium	Ba	137.36	2
4	2	Beryllium	Be	9.02	2
83	5	Bismuth	Bi	209.00	3,5
5	3	Boron	B	10.82	3
35	7	Bromine	Br	79.92	1,3,5,7,−1
48	2	Cadmium	Cd	112.41	2
20	2	Calcium	Ca	40.08	2
6	4	Carbon	C	12.00	4, −4
58	X	Cerium	Ce	140.13	2, 3, 4
55	1	Cesium	Cs	132.91	1
17	7	Chlorine	Cl	35.457	1,3,5,7, −1
24	6	Chromium	Cr	52.01	2,3,6
27	♯	Cobalt	Co	58.94	2,3
41	5	Columbium	Cb	92.91	3,5
29	1	Copper	Cu	63.57	1,2
66	X	Dysprosium	Dy	162.46	3
68	X	Erbium	Er	167.64	3
63	X	Europium	Eu	152.00	3
9	7	Fluorine	F	19.00	−1
64	X	Gadolinium	Gd	157.3	3
31	3	Gallium	Ga	69.72	2,3
32	4	Germanium	Ge	72.60	2,4
79	1	Gold	Au	197.2	1,3
72	4	Hafnium	Hf	178.6	4
2	8	Helium	He	4.002	0
67	X	Holmium	Ho	163.5	3
1	1	Hydrogen	H	1.0078	1
61	X	Illinium	Il	146.00	3
49	3	Indium	In	114.76	1,2,3
53	7	Iodine	I	126.92	1,5,7,−1
77	♯	Iridium	Ir	193.10	3,4,6
26	♯	Iron	Fe	55.84	2,3
36	8	Krypton	Kr	33.70	0
57	X	Lanthanum	La	138.92	3
82	4	Lead	Pb	207.22	2,4
3	1	Lithium	Li	6.94	1
71	X	Lutecium	Lu	175.0	3
12	2	Magnesium	Mg	24.32	2
25	7	Manganese	Mn	54.93	2,3,4,6,7
43	7	Masurium	Ma	98–99.5	6
80	2	Mercury	Hg	200.61	1,2
42	6	Molybdenum	Mo	96.0	2,3,4,5,6
60	X	Neodymium	Nd	144.27	3
10	8	Neon	Ne	20.183	0
28	♯	Nickel	Ni	58.69	2,3
7	5	Nitrogen	N	14.008	1,2,3,4,5
76	♯	Osmium	Os	191.5	2,3,4,6,8
8	6	Oxygen	O	16.00	−2
46	♯	Palladium	Pd	106.7	24(13)
15	5	Phosphorus	P	31.02	135−3
78	♯	Platinum	Pt	195.23	2,4
84	6	Polonium	Po	210.0	6
19	1	Potassium	K	39.096	1
59	X	Praseodymium	Pr	140.92	3
91	5	Protoactinum	Pa	234.0	5
88	2	Radium	Ra	225.97	2
86	8	Radon	Rn	222.00	0
75	7	Rhenium	Re	186.31	4,6.7(8)
45	♯	Rhodium	Rh	102.91	2,3,4
37	1	Rubidium	Rb	85.44	1
44	♯	Ruthenium	Ru	101.7	2,3,4,6,7,8
62	X	Samarium	Sm	150.43	3
21	3	Scandium	Sc	45.10	3
34	6	Selenium	Se	78.96	2,4,6
14	4	Silicon	Si	28.06	4
47	1	Silver	Ag	107.88	1
11	1	Sodium	Na	22.997	1
38	2	Strontium	Sr	87.63	2
16	6	Sulfur	S	32.06	2,4,6,−2
73	5	Tantalum	Ta	181.4	3,5
52	6	Tellurium	Te	127.01	2,4,6,−2
63	X	Terbium	Tb	159.20	3
81	3	Thallium	Tl	204.39	1,3
90	4	Thorium	Th	232.12	4
69	X	Thulium	Tm	169.40	3
50	4	Tin	Sn	118.70	2,4
22	4	Titanium	Ti	47.90	2,3,4
74	6	Tungsten	W	184.00	2,3,4,5,6
92	6	Uranium	U	238.14	3,4,5,6
23	5	Vanadium	V	50.95	2,3,4,5
87	1	Virginium	Va	224.0	1
54	8	Xenon	Xe	131.3	0
70	X	Ytterbium	Yb	173.04	3
39	3	Yttrium	Y	88.92	3
30	2	Zinc	Zn	65.38	2
40	4	Zirconium	Zr	91.22	4

X — Rare earths
♯ — Irregular

Types Acids Groups 2–7

	II	III	IV	V	VI	VII
Ortho:	H_2XO_2	H_3XO_3	H_4XO_4	H_3XO_4	H_2XO_4	HXO_3
Meta:		HXO_2	H_2XO_3	HXO_3		
Pyro:				$H_4X_2O_7$	$H_2X_2O_7$	

LAWRENCE ONCLEY

SOUTHWESTERN COLLEGE
WINFIELD, KANSAS

"PERSONNEL PLACEMENT VIEWS ON CHEMICAL EDUCATION"

To the Editor

DEAR SIR:

I was very much surprised to find in an article in your March, 1938, issue, which was entitled "Personnel Placement Views on Chemical Education," by Forrest A. Anderson, the following statement.

"As a by-product of the recent Depression, several hundred poorly trained chemists and chemical engineers have walked the streets of the various metropolitan areas in search of positions in laboratories or plants. These comprise the people with one or two years of college chemistry, some being crippled in one way or another, and some hard of hearing. Many of the foreign-born had difficulty with speech, and others, even with foreign names, were handicapped. In the temporary placement of such people in the chemical industries, the man and his lack of technic, the college that trained him, and the industry that tries to use his services, are all poorly served."

This statement, to my mind and experience, is a complete misstatement of the current state of affairs with regard to the employment of chemists in industry, and a conscious or unconscious attempt to justify the deplorable condition in which the young chemist finds himself today.

I would like to state, before I analyze the statement of Mr. Anderson, who I am and what education I have, experience, and so forth, so that the readers of this letter may understand upon what personal basis I write. I am a young man, twenty-three years of age, a graduate of New York University College of Arts and Pure Science, with a B.Sc., 1936, a major in chemistry, and a minor in physics, mathematics, and German. I have had a thorough training in all basic chemistry, that is, in inorganic, analytical organic and physical, as well as advanced courses in organic synthesis, physical chemistry, mathematics, and physics. My experience in the industry is at present limited to six

months in a paint laboratory where I was employed as a laboratory helper or rather Assistant Chemist, for which I received the munificent sum of $75 per month. Since losing this position I have been unable to find another with the exception of a "volunteer" one in a hospital which, because of financial reasons, I was unable to keep. Further, I am writing as one of those "(poorly?) trained chemists and chemical engineers"—who have been unable to find legitimate positions as chemists in industry.

Now let me proceed to the statement of Mr. Anderson. According to Mr. Anderson these poorly trained people comprise either people who have had only one or two years of chemistry, have no degrees from recognized institutions, are either partly deaf, foreign born, foreign named, etc. As regards the training of these unemployed chemists, I know, and my friends as well, numerous recent graduates in chemistry from our finest colleges and universities who have training and degrees in chemistry and engineering who are unable to obtain jobs in industry which are in any way connected with their training and commensurate with their ability. Many of these men are members of Phi Beta Kappa, Sigma Xi, etc. And as regards to their being crippled, etc., this is sheer nonsense. Firstly, because any man with a serious physical defect could never get through the average undergraduate chemistry course, and if he did it would be indicative of extraordinary talent and ability, and such a man would deserve a position just as much as a physically normal person. But Mr. Anderson knows just as well as I do that practically all these unemployed chemists and engineers are young, strong, and healthy, and upright Americans who are both willing *AND ABLE* to work, but for whom American industry at present can find no opening.

Further in regard to the foreign-born and *FOREIGN NAMED*. It is rather amusing to note in the American chemical industry there are at present numerous chemists of all nationalities, German, French, Norwegian, Italian, etc., who hold leading positions in our American chemical profession, and apparently their foreign-born origin was no drawback to their obtaining these positions. As to foreign names, what constitutes an American as against a foreign name? Are Roosevelt, La Guardia, Johnson, Ford, Jacques Loeb, Taylor, O'Reilly, American or foreign names? I think that when the author of the above-quoted statement says *FOREIGN*, he really means people who are *JEWISH* and to a lesser degree perhaps *CATHOLIC* and *NEGRO* people. Mr. Anderson's entire statement in regard to the what he calls foreign-born and foreign named has an underlying note of social, racial, and religious chauvinism. This chauvinism often manifests itself in newspaper advertisements of positions for chemists with statements such as: Christians Only, Anglo-Saxon, etc.

In conclusion, I would like to state that Mr. Anderson's article, well meaning as it may have been, has not contributed anything really constructive to the solution of placing young chemists in the chemical industry. Rather, I feel that certain statements which he has made and which I have endeavored to point out in this letter, tend to act as a barrier against a really intelligent and practical solution of this problem.

RICHARD A. LYON

1307 BOSCOBEL AVENUE
NEW YORK CITY

NOTES ON TITRATION

I. LIN

Fukien Christian University, Foochow, China

The removal of air bubbles in the tip of a Mohr buret is sometimes troublesome. The quick drainage method commonly used is not efficient, as the air bubble has a tendency to rise up in spite of the down-flow of the liquid. Advantage may be taken of the fact that if the tip is turned upward the gas bubble will, by its own nature, escape with the help of the flow of a very little liquid.

For quick titration, provision is usually made to reserve some of the original solution in a separate beaker to be added when the endpoint is just passed. We find that a glass tube closed with rubber and pinch clamp might serve as a stirring rod and a reservoir for liquid which can be drained out at the endpoint. This has the advantage of being quick, as rinsing can be done by sucking the final solution up into the tube, and accurate, as it eliminates the possible splattering in transferring.

AMERICAN DELEGATES APPOINTED TO TENTH INTERNATIONAL CONGRESS OF CHEMISTRY

Upon the invitation of the Italian Government, the United States, through the State Department, appointed delegates to the Tenth International Congress of Chemistry which was held in Rome, May 14 to 21, 1938. C. C. Concannon, chief of the Chemical Division, Bureau of Foreign and Domestic Commerce, Department of Commerce, was named chairman. The other delegates were Edward Bartow, Norman Bekkedahl, M. T. Bogert, H. A. Gardner, Thomas Midgley, Jr., W. A. Noyes, Sr., C. L. Parsons, Alexander Silverman, W. W. Skinner, J. W. Turrentine, and E. R. Weidlein.

The National Research Council and the National Academy of Sciences, responding to the invitation of the organizing committee of the congress, as their representatives at the thirteenth meeting of the International Union of Chemistry (under the auspices of which the congress meets) appointed the following councilors: Edward Bartow, vice-president of the International Union of Chemistry, head of the delegation, and M. T. Bogert, Alexander Silverman, James F. Norris, C. L. Parsons, and Robert E. Swain. The delegates were Ross A. Baker, Norman Bekkedahl, H. K. Benson, Gustav Egloff, Colin G. Fink, S. C. Lind, Thomas Midgley, Jr., Arthur Scott, and E. R. Weidlein. Alternates were Emma P. Carr, John V. N. Dorr, J. B. Ekeley, J. C. Hostetter, W. L. Jennings, R. E. Montonna, W. A. Noyes, Jr., Atherton Seidell, and J. W. Turrentine.

WILLIAM O. BROOKS
A. T. BURTSELL
R. K. CARLETON
TENNEY L. DAVIS
C. K. DEISCHER
J. HOWARD GRAHAM
B. CLIFFORD HENDRICKS

ABSTRACTS

J. W. HOWARD
D. C. LICHTENWALNER
GRETA OPPE

C. M. PRUITT
LEOPOLD SCHEFLAN
A. A. VERNON
E. D. WALTER
MARY ELVIRA WEEKS
SIDNEY WEINHOUSE
G. H. WOOLLETT

KEEPING UP WITH CHEMISTRY

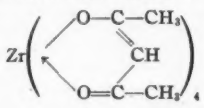
Coördination compounds. E. G. COX AND W. WARDLAW. *Science Progress*, **32**, 463–77 (Jan., 1938).—Werner's theory of coördination, which was first put forward in 1891, aimed at explaining the structure of that puzzling range of chemical compounds which chemists at that time conveniently shelved under the name of molecular compounds. They were formed by the combination of apparently saturated molecules and their structure appeared to be quite independent of the ordinary valency rules. Werner proposed for them a theory of molecular structure founded on entirely new principles. He pointed out that the structure was usually determined by the tendency of a central atom to attach to itself four or six or eight atoms or groups and that, for example, the molecular compounds $PtCl_2 \cdot 2KCl$ and $PtCl_4 \cdot 2KCl$ were actually the coördination compounds $K_2(PtCl_4)$ and $K_2(PtCl_6)$ when the square brackets enclose the coördination complex. Examples of atoms showing covalencies of 4, 6, or 8 are seen in the following compounds:

$$K_2[Zn(CN)_4],\ K[BF_4],\ Ba[BeF_4],\ [Cu \cdot 4NH_3]SO_4$$
$$[PtCl_4 \cdot 2NH_3],\ K_2[SiF_6],\ [Co \cdot 6NH_3]Cl_3,\ Na_3[AlF_6]$$
$$K_4[Mo(CN)_8],\ K_3[W(CN)_8][OsF_8]$$

Our present knowledge of the stereochemistry of quadricovalent-metals is summarized in the following table, in which □ represents a planar distribution of bonds and △ a tetrahedral. The extent of recent advances in this field is well shown by a comparison of this table with a corresponding one given by Sidgwick.*

Principal Valency	*Ni*	*Pd*	*Pt*	*Cu*	*Ag*	*Au*	*Pd*	*Sn*	*Co*	*Mn+*	*Be*
0	△										
1				△	△	?					
2	□	□	□	□	□		□	□	□ △	□	△ □?
3						□				□	
4		?	△								

Mention is made in the introduction to this article of a possible coördination number of eight. The number of elements which exhibit this covalency is very restricted, and the conditions for its realization are still obscure, despite attempts to formulate a satisfactory theory. Most of the elements showing a covalency of eight are heavy elements, although both zirconium and molybdenum with atomic numbers of 40 and 42, respectively, are definitely 8-covalent. W. G. Penney and J. S. Anderson conclude from their studies that eight elements, Zr, Mo, Ru, Ce, Hf, W, As, Th are known to form coördinated complexes with a covalency of eight. In the cases of certain compounds which appear to show this 8-covalency the possibility cannot be overlooked that they may have an alternation constitution. For example, certain salts contain eight molecules of water of crystallization and these are sometimes represented as being associated with the metal atom and conferring on it a covalency of eight, *e. g.*, $[Be, 8H_2O][PtCl_6]$. It is generally presumed that the distribution of the valencies of an 8-covalent atom is cubic, but it is very remarkable that in the cases of the tetraacetylacetonates of metals such as Zirconium no isomers have been detected.



* SIDGWICK, N. V., 'Some physical properties of the covalent link in chemistry," Cornell University Press, Ithaca, New York, 1933, p. 213.

It will be apparent that investigations on the lines indicated in this article are capable of wide extension to elements of other covalencies, such as odd covalencies of three, five, or seven. The results already recorded are of fundamental importance to modern stereochemistry, both in themselves and as a stimulus to advances from other directions, *e. g.*, in the application of quantum mechanical considerations to valency problems. The attention of those who wish to learn more of other aspects of coördination compounds is directed to the account of a symposium on complex compounds held by the American Chemical Society in 1936 when L. F. Audrieth emphasized that from a purely practical point of view there is also every reason for a more detailed study of complex inorganic compounds. Sir Gilbert Morgan, too, has stressed that at least one important metallurgical industry—the production of pure nickel—may be regarded as being dependent on the singular properties of a coördination complex, nickel carbonyl. R. K. C.

Black magic. ANON. *Ind. Bull. of Arthur D. Little, Inc.*, **133**, 4 (Feb., 1938).—There are several types of industrial "blacks"—gas blacks, lamp blacks, bone blacks, charcoal blacks, and iron oxide blacks. Most of these serve as pigments, but some are used in compounding rubber, deodorizing and decolorizing liquids, adsorption of gases, and in dry batteries. Carbon black, made from natural gas, is the most important, perhaps. A less familiar gas black is acetylene black used in dry batteries and racing tires. Its high absorptive capacity has occasioned its use as a filler for liquid oxygen explosives. In tinting values for paints and lacquers it gives a bluer undertone and a duller finish than natural gas blacks. Acetylene black is still an "industrial youngster," but it has several uses for which its special properties peculiarly adapt it. G. O.

Plasterers please note. ANON. *Ind. Bull. of Arthur D. Little, Inc.*, **133**, 3–4 (Feb., 1938).—This note for plasterers tells of a new hydraulic gypsum cement with characteristics far superior to other gypsum cements; namely, tensile strength especially in sanded mixtures, resistance to weather expansion and contraction, and resistance to mechanical wear. Tests have shown that it can be made from virtually any commercial grade of rock gypsum or synthetic gypsum at practically the same cost of Portland cement. Steps in the manufacture are: mixing ground gypsum with phosphoric acid and sodium phosphate, adding silica if necessary; forming pellets in a tumbling drum; calcining at 1800° to 2300° in a tunnel kiln. The final step is to grind the "clinker" usually with a catalyzer as an accelerator, the catalyzer being potassium sulfate and zinc sulfate. The coating of alkaline phosphates exert a marked effect on the properties of this gypsum. It has much to recommend it in the building industry. G. O.

To history—add nineteen thirty-seven. *Ind. Eng. Chem.*, **30**, 1, 3–14 (Jan., 1938).—A summary of the major events and developments in Chemistry and chemical industries. In 1912 the total investment in chemical industries was $3,000,000,000, while in 1937 the fluctuation in value of the ten companies listed on the New York Stock Exchange amounted to about $1,000,000,000. Recovery of bromine from sea water has been doubled. Increased production of radium in Canada has reduced the price below $30 per mg. About fifty grams will be produced there in 1938. A plant producing hexahydric alcohols by electrolytic reduction from glucose has begun operations near Wilmington. A new electrothermal process has resulted in the production of Mg at costs below that of Al. Fluorides can be removed from drinking water by filtration through granulated animal bones.

Ethylcellulose has been added to the family of transparent wrapping materials.

The "Children of Prosperity" at the Exposition presented many of the advances in chemistry. New detergents and penetrants, new resins, plasticizers, pigments, insecticides, hormones for stimulation of plant growth, new esters for flavoring, materials for waterproofing fabrics, fertilizers, inhibitors in pickling ferrous metals, rug root to prevent slipping of rugs on floors, silicate adhesives with special properties, sweet potato starch, dehydrated turpentine, and others are described. Eighty-five items are listed. The use of tetrahydroxyquinone as an internal indicator in direct titration of sulfates is of interest to the analyst.

Element 87, named Virginium, was reported rediscovered and christened Mavadium. Vitamin A was isolated as a pure crystal, as was also catalose. A list of the Chemical Awards for the year is given. D. C. L.

Chia, perilla, tung, and soy. ANON. *Ind. Bull. of Arthur D. Little, Inc.*, **134,** 2 (Mar., 1938).—These four oil-producing plants are being stressed as profitable crops for the South to improve the soil and to furnish oil and press-cake, as well as plastics. Much of the large mill capacity for crushing cotton seed for oil should also be available for crushing other seeds. The United States now raises but a small proportion of most of the oils required in this country for the manufacture of paints, varnishes, linoleum, and printing inks. The present international situation makes it obvious that steps should be taken toward providing for our national self-sufficiency. Tung or Chinawood trees have been planted in the region close to the Gulf of Mexico, but the yield from these young trees is small. Flaxseed, long grown in the northwestern states, has varieties suited for the south as shown by the planting of about one thousand acres in southeast Texas. Perilla oil thrives in sandy loam and in sections where there is ample rain. It thrives in Virginia. A newcomer from Mexico is chia, pronounced chee-ah. This plant belongs to the salvia division of the mint family. It needs a long growing season and well-watered soil. Even the sunflower is a good oil producer. G. O.

Vaporous metal discourse. ANON. *Ind. Bull. of Arthur D. Little, Inc.*, **133,** 2–3 (Feb., 1938).—Magnesium and zinc are the metals of this "vaporous discourse," and the discourse centers about the continuous reduction of metallic oxides to mixtures of metallic vapors and other gases from which the metals may be condensed. Heretofore, the only commercial method of producing magnesium has been the electrolysis of magnesium chloride. Quite recently completely anhydrous magnesium chloride, obtained by heating purified magnesite with coke and chlorine, has won extended use. Now production of magnesium from its oxide, burned magnesite, by electrothermic distillation has been developed. This is done at such sites as Grand Coulee Dam where magnesite and cheap power are both at hand. Coke is the reducing agent usually employed. Were the gaseous mixture to cool normally, the reaction would reverse itself, but if the gases are suddenly cooled, the magnesium condenses before it has time to reoxidize. For this quick cooling several methods are used. After cooling, the magnesium is redistilled in the absence of oxygen and condensed as a liquid of high purity, ready for alloying or casting. Easily volatilized zinc has for centuries been prepared by reduction-distillation of its oxides by carbon. The American Smelting and Refining Company has recently developed a new vertical retort process which dispenses with briquetting. The oxide is reduced to metallic zinc vapor by carbon monoxide. If natural gas is substituted for carbon monoxide as the reducing medium, coke is unnecessary. In either event, the resulting gases filtering through incandescent coke reduces any remaining carbon dioxide or zinc oxide present, thus permitting ready condensation of the zinc vapor to a liquid suitable also for casting or refining. G. O.

After the gas buggy age. ANON. *Ind. Bull. of Arthur D. Little, Inc.*, **133,** 1–2 (Feb., 1938).—Because of our rich petroleum reserves, American interest in gasoline substitutes research lags behind foreign interest in such research. Foreign developments are motivated by that strong incentive, the desire for economic self-sufficiency. Coal hydrogenation, synthesis of alcohols or gasoline from coal, or alcohol by fermentation all yield fuels expensive if in competition with imported untaxed gasoline, but they are liquid fuels capable of emergency use as gasoline substitute. Three foreign developments in motor fuels are economically sound enough to justify interest in this country. These are the use of compressed gas, of producer-gas generated on the vehicle, and of pulverized coal. The use of gas as a motor fuel started during the World War with collapsible gas bags on the tops of French busses. Metallurgy has made possible the use of light weight cylinders to carry compressed gas at 3000 pounds pressure. With the present tax on gasoline and none on gas, it appears that a gas company could make money and a transport company in the same city could save money by the use of compressed gas. Producer-gas, made on the truck, has received widespread study and commercial use in England, Germany, Japan, Italy, and South Africa. The MacDonald cross-draft producer in England, the down-draft producers in Germany, and the Koela up-draft in South Africa are examples of commercial developments. Fuel used varies from corncobs to wood, charcoal, low-temperature coke, non-caking bituminous coal, and anthracite. Continuous research has led to several types of powdered or pulverized coal engines. One of these is the Rupa engine. G. O.

Parson Priestley's element. ANON. *Ind. Bull. of Arthur D. Little, Inc.*, **135,** 1–2 (Apr., 1938).—This article visualizes the possibilities of industry with a cheap supply of industrial oxygen. Theoretically, it should be possible to obtain oxygen by permitting oxygen from the atmosphere to diffuse through a semi-permeable membrane, permeable only to oxygen, into a chamber where its pressure would be equivalent to its partial pressure in the atmosphere, and then pumping it out of the chamber and discharging it at one atmosphere of pressure. In practice, such a simple scheme is limited by the membrane; but even so, in large plants today where air is liquefied, it has become possible to obtain pure oxygen at a relative low cost. Figures from Germany show an extraordinarily low cost of a quarter of a cent a pound. The incentive to use oxygen enriched air or impure oxygen in industry is stronger in Europe than in this country: but it is of interest to contemplate some of the uses of low-cost oxygen. The principal use would be in processes employing oxidation and the advantage would be in the high temperature possible. It is said that in Germany most of the cheap oxygen is employed in hydrogenation processes or continuous gas producers. G. O.

HISTORICAL AND BIOGRAPHICAL

Sir Joseph Bank's mantelpiece. T. MARTIN. *Nature*, **141,** 437–9 (March 12, 1938).—A fine old mantelpiece from the London home of Sir Joseph Banks (1743–1820), president of the Royal Society, has recently been erected in the library of the Royal Institution. After Banks returned to England from his voyage to the South Seas with Captain Cook in 1771, the fine house at 32 Soho Square was built to house his scientific collections and library and to afford a meeting-place for scientists. Among the frequent guests were Henry Cavendish, Dr. W. H. Wollaston, Davies Gilbert, Sir Humphry Davy, Thomas Young, Sir William Herschel, and "even John Dalton in his Quaker dress." Even the business meetings of the Royal Society were occasionally conducted there, and the Royal Institution was founded there in 1799.

When this house was demolished in 1937 [see *Nature*, **139,** 280 (1937)], two of the mantelpieces were purchased by Sir Robert Hadfield and presented, one to the Royal Society and the other to the Royal Institution. Although the central panel of the mantelpiece from the council chamber, "a Wedgwood in green and white," had been stolen and replaced by another one before this purchase, the moulds for the original panel were finally found "after a search in the dusty mould rooms of Messrs. Josiah Wedgwood and Sons." While the firm was preparing to make a replica, the original panel, in excellent preservation, was found and restored to the mantelpiece in the Royal Institution. M. E. W.

Memories of Rutherford in Manchester. H. GEIGER. *Nature*, **141,** 244 (Feb. 5, 1938).—"When I look back on the five years which I spent with Rutherford as a young physicist in Manchester, . . . I see his quiet research room at the top of the

physics building. . . But I also see the gloomy cellar in which he had fitted up his delicate apparatus for the study of the α-rays." Professor Geiger also recalls that Rutherford "threatened the severest penalties" for anyone who allowed emanation to escape, for it spread rapidly throughout the building and interrupted all experiments with the electroscope. "One day I noticed that it had become impossible to use an electroscope in my room, where I had fitted up the first counting experiments for Rutherford. . . We were not long in discovering that the emanation had come from Rutherford's own laboratory, where at that moment he was actively engaged with his experiments. . . I told him that once again it was futile to attempt to do any work, for the whole building was full of emanation, all of which came from his room. Rutherford looked surprised, and replied, 'Well, there you have further proof of the power inherent in this emanation.' With this remark he left me; but he soon returned, suggesting that I must be somewhat upset, and that I needed a little fresh air. He took me forthwith in his car for a ride beyond the turmoil of the city, and he was soon discoursing on his own experiments and on all the problems that were yet to be solved. Nothing was so refreshing nor so inspiring as to spend an hour in this way, alone with Rutherford." M. E. W.

Publication of old scientific works. ANON. *Nature*, **141**, 194 (Jan. 29, 1938).—A committee at Prague, presided over by Professor B. Nemeč, has been studying the possibility of publishing rare old scientific works. The committee felt that the undertaking should be entrusted to the International Organization for Intellectual Coöperation and that some of the researches of Copernicus, Robert Hooke, John Dalton, Charles Darwin, Lazaro Spallanzani, and Carolus Linnaeus might well be published. M. E. W.

Emanuel Swedenborg (1688–1772). ANON. *Nature*, **141**, 192–3 (Jan. 29, 1938).—On January 29th the two hundred fiftieth anniversary of the birth of Emanuel Swedenborg was observed throughout the world. In 1716 he published "Daedalus Hyperboreus," a repository of contemporary inventions and experiments. His later writings covered all phases of science. M. E. W.

Jean-Baptiste Senderens (1856–1937). E. K. RIDEAL. *Nature*, **141**, 148 (Jan. 22, 1938).—J. B. Senderens, the great authority on contact catalysis, died on September 26, 1937. In 1899 Sabatier and Senderens found that finely divided nickel catalyzes the hydrogenation of the vapors of many organic substances. The first patent by Senderens, in 1901, was for the production of aniline from nitrobenzene. He confined his attention to hydrogenations in the vapor phase, leaving the treatment of liquids, including the hardening of fats and the hydrogenation of coal and liquid tar, to other workers. He believed that in contact catalysis intermediate compounds are formed between reactant and substrate. He observed that acetylene can be hydrogenated to ethane without the addition of hydrogen; the hydrogen is supplied by the simultaneous dehydrogenation of part of the acetylene. "This reaction may be regarded as the prototype of important reactions involved in the oil industry, where the fundamental processes consist in the catalytic making and breaking of carbon-carbon and carbon-hydrogen bonds." M. E. W.

Scientific centenaries in 1938. E. C. SMITH. *Nature*, **141**, 13–5 (Jan. 1, 1938).—The scientific centenaries which occur this year include, among others, the bicentenary of the death of Hermann Boerhaave, professor of chemistry at the University of Leyden; the centenaries of the death of P. L. Dulong, professor at the École Polytechnique in Paris, Charles Tennant, who in 1799 patented a process for the production of bleaching powder, and of Bernard Courtois, the discoverer of iodine; and the centenaries of the birth of Sir William Perkin, who at the age of eighteen years discovered aniline mauve, of Ernest Solvay, the inventor of the Solvay process of manufacturing soda, and of Lecoq de Boisbaudran, the discoverer of gallium. M. E. W.

Twenty-fifth anniversary of the Laue diagrams. ANON. *Nature*, **141**, 600 (Apr. 2, 1938).—The twenty-fifth anniversary of Laue's first X-ray analyses of crystal structure has been celebrated by *Die Naturwissenschaften* by the publication of two articles on the progress made in this branch of crystal chemistry, one of them by F. Laves [*Naturwiss.*, **25**, 705, 721 (1937)] and the other by F. O. Schmitt [*Naturwiss.*, **25**, 709 (1937)]. M. E. W.

GENERAL

The pharmaceutical farmer. ANON. *Ind. Bull. of Arthur D. Little, Inc.*, **132**, 1–2 (January, 1938).—The drug store still sells drugs. The present vogue for pure concentrates calls not only for synthetic materials from chemical factories but also for the essential ingredients of many natural products under the name "isolates." Drugs are plants, and as such are objects for agricultural consideration. There has always been an interest in drug plants in America. Sassafras plants brought back by Columbus amazed the doctors of Spain. Then came the finding of ginseng. We raise a large percentage of our peppermint and spearmint. Mint is harvested by machinery, like hay. Pyrethum was imported originally from Dalmatia and now principally from Japan for the making of fly-sprays. We import only the dry flower heads, rich in the numbing agents that drop the flies; but it has been suggested that this might be a profitable crop for the American farmer, since it has been found to grow well in Pennsylvania, Maryland, Connecticut, Massachusetts, the Great Lakes States, and parts of Nebraska and South Dakota. At the present it looks as if the desert country might raise ephedra. G. O.

Give Washington its due. ANON. *Ind. Bull. of Arthur D. Little, Inc.*, **131**, 2–3 (Dec., 1937).—A vast amount of scientific and technical information is available in Washington, not only from government sources but also from many scientific organizations and trade associations maintaining headquarters there. There are over eighty-five laboratories in the vicinity of Washington working closely with other laboratories and experiment stations throughout the country. Recently completed are the new Eastern Experiment Station of the Bureau of Mines and the new building of the American Pharmaceutical Association, while plans are being announced for a Cancer Institute. The Department of Agriculture divides its work among Bureaus; for example, the Bureau of Chemistry and Soils develops processes for the utilization of farm products and byproducts, conducts chemical, physical, biological, microscopic, and technical investigations of foods, feeds, drugs, and raw materials. Other Bureaus of interest to industrialists are Animal Industry, Agricultural Economics, Biological Survey, Agricultural Engineering, and the Food and Drug Administration as well as the Forest Service and Experiment Stations. The Bureau of Standards has attained an international reputation as one of the foremost institutions of its kind. The availability of inexpensive helium is the result of the work of the Bureau of Mines. It recently developed a new method of separating potassium and sodium chlorides now in use on the potash deposits of Carlsbad, New Mexico. Lithium is at present under investigation, due to the impending exhaustion of low-cost lithium reserves and increasing demand for lithium chloride in air conditioning. The Federal Government is not the only source of technical and scientific information. Located in Washington are many trade associations, such as the National Canners' Association, the National Institute of Dry Cleaners, and the National Paint, Varnish and Lacquer Association, all of which maintain research laboratories. There are numerous private and semiprivate institutions, such as the Carnegie Institution of Washington, the National Academy of Sciences, and the Smithsonian Institute. G. O.

Radiant warmth. ANON. *Ind. Bull. of Arthur D. Little, Inc.*, **135**, 4 (Apr., 1938).—Radiant type heating and cooling are the more recent advances in room heating and cooling. The gorgeous tapestries that adorned the massive stone walls of the feudal castles furnished the clue to these experiments with air-conditioning. It has been found with the aid of test chambers lined with aluminum foil that heat-transfer panels of steel, built into the walls, are sufficient to heat or cool the occupants of the room. One of the problems, however, is the protection of the cold plates from warm room air and moisture so that condensation and defrosting may be eliminated. G. O.

RECENT BOOKS

QUALITATIVE ANALYSIS BY SPOT TESTS, Inorganic and Organic Applications. *Fritz Feigl*, Professor of Analytical Chemistry, University of Vienna. Translated from the Second German Edition by *Janet W. Matthews*, Imperial College of Science and Technology, London. Nordemann Publishing Company, Inc., New York City, 1937. ix + 400 pp. 24 figs. 15.5 × 23.5 cm. $7.00.

With the increasing tendency of the chemist, either by necessity or as a matter of convenience, to deal with smaller and smaller amounts of material, this book is a welcome addition to the English analytical literature. It is a translation of the Second German Edition (1935) of QUALITATIVE ANALYZE MIT HILFE VON TUPFELREAKTIONEN with the omission of the rather comprehensive theoretical portion, and the addition of some new material. It is intended that a translation of the theoretical portion will be published as soon as a demand for it is recognized.

The text is divided into eight parts, the first two of which consist of general remarks and a description of the essential apparatus employed in making the tests. The latter part contains nineteen illustrations of apparatus with the scale of drawing indicated in each case. Part III gives tests for about forty positive ions which includes (A) metals of the hydrogen sulfide group, (B) metals of the ammonium sulfide group, (C) metals of the ammonium carbonate group, and (D) the alkali metals. The platinum group metals and many of the less common metals are included in this section. Tests for more than thirty acid ions are given in Part IV, while Part V consists of the systematic analysis of mixtures. The latter includes the following: (A) Gutzeit's procedure, (B) Heller and Krumholz' procedure, (C) analysis of positive ions according to Krumholz, (D) analysis of alloys according to Heller, (E) detection of anions in a mixture, and (F) detection of substances insoluble and sparingly soluble in acids. Part VI is concerned with organic spot tests for the detection of elements commonly found in organic compounds, such as the halogens, sulfur, nitrogen, phosphorus, and arsenic; the identification of characteristic organic groups, and the identification of specific organic compounds. In Part VII a large number of applications of spot reactions is given for the identification of metals in alloys, minerals and rocks, foodstuffs and so forth. A number of applications to organic substances is also included in this section. Part VIII is a tabular summary of the sensitivities of spot tests, inorganic and organic.

Throughout the text descriptions of tests are accompanied by information relative to the limit of identification of the ion in question, the concentration limit and directions for the preparation of the required reagents. The method of performing the test is adequately described in each case. In many instances several tests are given for a single ion, the choice of which depends upon the type of substance containing the ion, the availability of reagents and the amount of the substance present. Numerous references to the literature are also included.

To those engaged in technical analytical work and in the teaching of analysis this text will be very useful. It will also prove useful to scientific workers who are not highly trained in chemistry, since the tests are simple in operation and in interpretation.

W. C. JOHNSON

UNIVERSITY OF CHICAGO
CHICAGO, ILLINOIS

THE ELEMENTS OF QUANTUM MECHANICS. *Saul Dushman*, Ph.D., Assistant Director, Research Laboratory, General Electric Company, Schenectady, New York. John Wiley and Sons, Inc., New York City, 1938. xiii + 452 pp. 74 figs. 14.5 × 23.5 cm. $5.00 net.

The book represents an effort on the part of the author to provide an introduction to quantum mechanics for chemists and physicists whose formal mathematical training does not extend beyond calculus. It is based upon Dr. Dushman's excellent series of articles on this subject in the JOURNAL OF CHEMICAL EDUCATION. It will, therefore, be no surprise to the readers of THIS JOURNAL that he has come as near to achieving his purpose as it is possible to do without over-simplification. Numerous supplementary notes, annotated references for collateral reading, and an extensive set of appendixes contribute to the understandability of the book. It is well designed to give the reader a working knowledge of the methods of application of the Schrödinger equation to concrete problems in chemistry and physics. In conformity with this purpose, the more abstract formulations of quantum mechanics are not stressed.

The Schrödinger equation is introduced early in the book. Its mathematical features are illustrated by a discussion of the differential equation of a vibrating string. Its physical features are illustrated with a minimum of mathematical complication by an aptly chosen set of potential barrier problems. After these introductory chapters the harmonic oscillator, the rigid rotor, and the hydrogen atom are treated in detail by conventional methods. Perturbation theory and the variation principle are presented in the usual manner and their use is illustrated by applications, including the helium atom and the calculation of van der Waals forces. The latter chapters of the book provide an excellent introduction to the quantum mechanical theory of the chemical bond. Other topics treated are the rotation and vibration of diatomic molecules and the elementary theory of the emission and absorption of radiation by matter.

Dr. Dushman's book can be recommended without hesitation to chemists who are interested in gaining familiarity with the working methods of quantum mechanics at the expense of a certain amount of serious study.

JOHN G. KIRKWOOD

THE UNIVERSITY OF CHICAGO
CHICAGO, ILLINOIS

ACID-BASE INDICATORS. *I. M. Kolthoff*, Ph.D., Professor of Analytical Chemistry, University of Minnesota, Fourth German Edition (1932) translated (1937) by *Charles Rosenblum*, Ph.D. The Macmillan Company, New York City, 1937. ix + 414 pp. 23 figs. 14 × 21.5 cm. $7.00.

The first part of the book (one hundred pages) is devoted to a description of acids, bases, salts, and amphoteric electrolytes from the viewpoint of the law of mass action, supplemented by useful formulas and tables of dissociation constants and activity coefficients. "Because of the great importance of the general question of acid-base equilibrium, the clear and fruitful views of Brønsted are exhaustively considered in a special (fourth chapter)"; the treatment follows Brønsted's 1928 monograph in *Chemical Reviews* very closely. The next one hundred thirty-six pages treat the theory, formulas, and properties of the principal indicators. The effects of solvents upon indicators is discussed. The remainder of the book is devoted to the practical determination of pH by colorimetric methods; much useful information on buffers is given in this section.

It is a pity that the author and translator did not collaborate and issue an up-to-date 1937 edition in English of this valuable monograph instead of simply translating an edition which is now five years old. Since 1932, a large number of precise and accurate measurements have appeared in the *Journal of the American Chemical Society* dealing with the determination of dissociation constants of the common acids and bases by galvanic cells without liquid junction and by conductance methods which are no longer open to theoretical objections (see pages 75–79); also many precise studies of the salt effects upon dissociation constants and indicators. These data will supersede many of those given. It is unfortunate that references are not given to these important contributions.

In spite of these shortcomings the analytical chemist will find that the book contains a wealth of experimental material which cannot help but prove useful.

VICTOR K. LA MER

COLUMBIA UNIVERSITY
NEW YORK CITY

SUPPRESSION OF WEEDS BY FERTILIZERS AND CHEMICALS. *H. C. Long*, B.Sc. (Agric.), Ministry of Agriculture and Fisheries. Published by the author, "The Birkins," Orchard Road, Hook, Surbiton, Surrey, England, 1934. 57 pp. 17 figs. 14 × 21.5 cm. 6d.

In a foreword to this handbook on herbicides Sir Daniel Hall points out that high labor costs are forcing British agriculture away from the traditional methods of hand culture and toward "any cheap methods that science can offer." Chemicals as a means of weed control are one of the more obvious possibilities. The present publication, as with most European writings on chemical weed killers, is concerned chiefly with the control of annual weeds growing in grain. The discussion is chiefly a compilation of results of European experiments with sulfate of ammonia, nitrate of soda, calcium cyanamide, sulfuric acid, copper sulfate, iron sulfate, and kainit. Good kills were obtained with most of these, but the economy of the chemical method over cultural methods of controlling weeds in cereals is not clearly demonstrated. Sodium and potassium chlorate are discussed only briefly, since these are not widely used in Britain, owing to their sterilizing effect and high cost. Unlike America, there appears to be little need of them for killing bindweed and similar deep-rooted, destructive species. Arsenicals, likewise, are of slight interest in Britain except for clearing paths. A chapter on miscellaneous chemicals includes salt, lawn sands (a mixture of sulfate of ammonia and sulfate of iron), nitric acid, carbolic acid, hydrochloric acid, nickel sulfate, copper nitrate, carbon bisulfide, ammonium thiocyanate, potassium chloride, washing soda, caustic soda, sodium bisulfate, and oils. Lime and fertilizers are discussed at some length, but their value as herbicides appears more in their stimulating effect on crops than in any direct repressing effect on weeds.

L. W. KEPHART

DIVISION OF CEREAL CROPS AND DISEASES
BUREAU OF PLANT INDUSTRY
UNITED STATES DEPARTMENT OF AGRICULTURE
WASHINGTON, D. C.

MARGARETHE VON WRANGELL. Das Leben einer Frau, 1876–1932. *Prince Wladimir Andronikow.* Albert Langen-Georg Müller Verlag, Munich, 1936. 383 pp. 17 illustrations. RM. 8.50.

In 1932 an agricultural chemist of world renown, Margarethe von Wrangell, died in her adopted country, Germany. Her husband, Prince Wladimir Andronikow, has recently published a splendid biography of her, based on diaries, letters, and reminiscences. The book is embellished with expressive portraits and other illustrations and with many poems and short essays showing the literary gifts of Margarethe von Wrangell. A bibliography of her scientific publications has been contributed by Dr. L. Meyer of Hohenheim.

On Christmas Day in 1876 the bells of the forty times forty churches of old Moscow were chiming gaily, and Baron von Wrangell and his family were especially happy over their yuletime gift, little Margarethe, who lay asleep under the lighted tree. Her first allusion to chemistry appears in a letter to her grandfather when she was eight years old. "Our doctor," said she, "has prescribed phosphorus for the mice and arsenic for me." Her early childhood was spent on one of their estates at Ufa, and it was there that she learned to love and understand plants, little dreaming that some day she was to become the head of a great institute of plant nutrition in Germany.

When she learned in 1904 that women students were not welcome at Greifswald or Marburg, she chose Tübingen, which for the first time in its history was admitting a few women. "I have been especially welcomed," she wrote, "by the chemist Wislicenus." Although some persons regard formulas and equations as the dry bones of chemistry, Margarethe von Wrangell felt otherwise. "I find something so classical about chemistry," said she, "the purity and beauty of the formulas without the inflexibility of the mathematical numbers, but with life always pulsing through them."

In 1909 her doctor's thesis entitled "Isomerism of the formyl ester of glutaconic acid and its bromine derivatives" was published at Tübingen, and in the same year she became an assistant at the Agricultural Experiment Station of the Royal Agricultural Society at Dorpat, Esthonia, where her ability soon became recognized. Because of the routine nature of the work at Dorpat, however, she went to London to study radioactivity under Sir William Ramsay.

In a letter to Professor Wislicenus she wrote, "Sir William is very pleasant and especially friendly and charming to me. . . . . After a few failures, I decided to work quietly for a while, all alone, and try out something new. I read a great deal and made my experiments on the basis of my beloved periodic system. After three weeks, during which I hid from Ramsay, . . . I grasped my four beloved little smeary preparations, wrote down in English everything I had found out, and went to Ramsay. . . ." To her surprise, he congratulated her heartily.

Margarethe von Wrangell later continued these thorium researches at Strassburg under Professor Edgar Wedekind. "For almost a year and a half," said he, "I enjoyed the tenacious and tireless collaboration of this broadly educated, methodical woman chemist. . . . . The research included the first analytical experiments on natural zirconia from Brazil. . . . . I already foresaw a promising future for her in chemical research."

In 1911 Margarethe von Wrangell went to Paris to study with Mme. Curie. "I am working," said she, "with one hundred liters of uranium [solution], a quantity which would fill two wine casks. Mme. Curie, who was very much interested in my thorium research, entrusted this treasure to me because I had had experience with the thorium." Because of the serious illness of Mme. Curie, however, Margarethe von Wrangell soon left Paris and returned to Revel, where she was placed in charge of the experiment station of the Esthonian Agricultural Society.

When sugar became very scarce in 1916, she wrote, "The Esthonian estates own three hundred modern, well-equipped distilleries, which at the beginning of the war were in full operation but are now idle because of prohibition. It ought to be possible without great difficulty to alter the idle distilleries for the manufacture of sugar and potato starch." She personally conducted a sirup plant which had been transformed from a distillery according to her own plans, but the Russian Revolution soon made it impossible for her to continue. One morning as she was investigating the naturally occurring Esthonian phosphates, a committee ordered her to surrender her authority over the laboratory. She refused to sign the paper. A few days later she was arrested at three in the morning at her home, and for about three weeks she was imprisoned in an old shed with a hundred other women. To keep up their spirits after dark, they gave lectures on various subjects, and Fräulein von Wrangell spoke on Germany's food supply during the war and on German discoveries and syntheses. Her subsequent researches in Germany, on fertilizers prepared from Esthonian minerals containing potassium and phosphorus, laid the foundation for a flourishing fertilizer industry in Esthonia.

Because of her bitter experiences, she shunned human society. "I lived with the plants," said she. "I laid my ear to the ground, and it seemed to me that the plants were happy to be able to tell something of the secrets of their growth." These words from her brief autobiography have recently been carved on a beautiful memorial slab at Hohenheim.

In 1922 she became a member of the Kaiser Wilhelm Institute in Berlin, which was directed by Fritz Haber. The rich Stassfurt deposits provided German vegetation with a plentiful supply of potassium, Haber's fixation process yielded plenty of available nitrogen, but Germany was obliged to import its phosphates at

great expense. After the Versailles Treaty, the Thomas slag of Lorraine was no longer available to Germany for phosphate fertilization. Fräulein von Wrangell showed that German soils are not so deficient in phosphorus as had formerly been believed and that, by choosing the right crops, the proper accessory fertilizers, and suitable means of cultivation, the phosphorus resources could be mobilized. Her book on the phosphoric acid nutrition of plants was given wide publicity by the German press, and Fritz Haber hailed her discoveries as a great advance in agriculture.

In 1923 the new institute of plant nutrition was erected for her at Hohenheim according to her own plans, and she became the first woman in Germany to hold a full professorship. During the decade from 1920 to 1930 she published twenty-six papers: on the phosphoric acid requirements of different plants; a rapid colorimetric method of determining phosphoric acid in very dilute solutions; the laws of solubility and their application to tertiary phosphates; the phosphoric acid content of natural soil solutions; phosphoric acid absorption and soil reaction; the solubility and availability of the phosphoric acid in the soil; determination of potassium in very dilute solutions such as those in the soil; the composition of soil solutions and the growth of plants in very dilute solutions; the speed of absorption of ions by plants; nitrogen fertilization and the color of flowers; atmospheric iodine and plants; and iodine as a plant food.

Several of her relatives had been killed during the Russian Revolution and Prince Wladimir Andronikow was reported to have been shot. One day she received an unsigned picture postcard from Serbia in his very familiar handwriting. The prince had read more than one obituary of himself and had taken this means of letting her know, in spite of the strict censorship, that he was still among the living. After their marriage in 1928, she continued to direct the Institute of Plant Nutrition at Hohenheim and the prince helped her prepare her great work on "The nutrition and fertilization of plants" for the press. In a public lecture she once said, "Liebig's immortal thoughts still stand as the guiding star of German agriculture."

MARY ELVIRA WEEKS

UNIVERSITY OF KANSAS
LAWRENCE, KANSAS

EBULLIOMETRY. *Wojciech Swietoslawski*, Professor of Physical Chemistry at the Polytechnic of Warsaw. Translated by *S. Partyka* and *A. Truszkowski*. Chemical Publishing Company of New York, Inc., New York City, 1937. Second edition. x + 204 pp. 53 figs. 13.5 × 21 cm. $3.00.

This book is a comprehensive review of the theoretical and experimental work of Professor Swietoslawski and his students and collaborators at the Polytechnic of Warsaw, since 1924 continuing to date, on the determination and study of vapor pressure and boiling point characteristics of all types of solutions and mixtures, including the development of a variety of experimental apparatus for exact measurements of these characteristics.

Professor Swietoslawski's researches, as presented in this book, are outstanding and might be termed classical in their fundamental approach and careful experimental investigation of what seems to be a simple subject, but which actually is one of the most complicated and difficult when it is desired to derive exact relations between composition, vapor pressure, and boiling point under specific static, dynamic, and apparatus conditions. The results of these researches, in the form of general relations, illuminating explanations of actual mechanism of vaporization of complex and two-phase mixtures, apparatus and procedures for measuring purities with great exactness, should be of considerable interest to research workers dealing with distillation and rectification, and vaporization processes generally.

The book should be of educational value in advanced study of the physical chemistry of solutions, and in chemical engineering courses on distillation, evaporation, and similar processes involving vaporization phenomena. It will serve as a reference to most outstanding research work on its subject.

WALTER J. PODBIELNIAK

8312 SOUTH CHICAGO AVENUE
CHICAGO, ILLINOIS

FUNDAMENTALS OF BIOCHEMISTRY WITH LABORATORY EXPERIMENTS. *Carl L. A. Schmidt*, M.S., Ph.D., Professor of Biochemistry, University of California, and *Frank Worthington Allen*, Ph.D., Instructor in Biochemistry, University of California. McGraw-Hill Book Company, Inc., New York City and London, 1938. xiv + 388 pp. 29 figs. 13.5 × 20.5 cm. $3.00.

This text provides laboratory instruction over a rather wide range of biochemical topics together with a background of discussion. There is a group of laboratory experiments intended for all students and another group of special, more advanced experiments for groups of two or more students. The latter are intended, "to teach the student the sources of the facts of biochemistry, to integrate information, to carry out a well-controlled experiment, and to present the facts in a coördinated and logical manner." The discussion part of the text is not intended to replace a course of lectures.

The text "does not aim to cover all aspects of the field of biochemistry." Following a chapter of directions which includes an excellent description of the balance and the colorimeter and their use, the following subjects are considered: I. Biological Variation and the Analysis of Experimental Results; II. Preparation of Standardized Solutions of Acid and Alkali; III. Hydrogen Ion Concentration; IV. Neutrality Regulation in the Body; V. Enzymes; VI. Mineral Metabolism; VII. Vitamins; VIII. The Endocrines; IX. The Chemistry and Metabolism of the Lipids; X. Bile; XI. The Chemistry and Metabolism of the Carbohydrates; XII. Chemistry of Amino Acids and Proteins; XIII. The Metabolism of Proteins. Urine and Blood Analysis; and XIV. Energy Exchange. There is an appendix containing dietary tables, problems, atomic weights and table of logarithms. There is also a well-prepared index.

Students employing this text will require thorough preparation in general and organic chemistry and in quantitative analysis. If the text is used faithfully, they should acquire a fundamental knowledge of those phases of biochemistry which are covered by the text. In addition, they should possess a highly desirable acquaintance with the literature because one of the very admirable features of the text is an excellent list of suggested readings at the beginning of each subject with additional references for each of the special experiments. The readings and references include the best modern texts and reviews as well as citations to original papers in American and foreign journals.

The text is concisely and clearly written and is well illustrated with chemical formulas and figures. There are a few errors and contradictions which will no doubt be corrected in future editions. There are some minor omissions and failures to clarify terms which would have to be taken up in the supplementary lectures. The major omission is that of colloids, even the word colloid apparently having been studiously avoided.

L. S. PALMER

UNIVERSITY OF MINNESOTA
ST. PAUL, MINNESOTA

A BRIEF INTRODUCTION TO THE USE OF BEILSTEIN'S HANDBUCH DER ORGANISCHEN CHEMIE. *Ernest Hamlin Huntress*, Ph.D., Massachusetts Institute of Technology. Second edition. John Wiley and Sons, Inc., New York City, 1938. x + 44 pp. 4 charts. 14.5 × 22.5 cm. $1.00 net.

It is human not to bother about schemes of classification unless one is forced to. Probably the majority of Beilstein users rely principally on the volume labels and volume indexes. When the general index appears they will turn to that. This simple plan answers surprisingly well, for the indexes are good ones.

Nevertheless, it is safe to say that those who will not trouble to learn the general principles of the Beilstein arrangement lose time in the long run. The scheme is really not complicated, considering the great diversity of organic compounds, but it needs some explanation.

There are at least three published guides to Beilstein's HANDBUCH but only one, Huntress' pamphlet, is in English. It can be read in an hour or less but will continue to be useful for reference. It is a very clear presentation, accompanied by helpful charts. It might well be supplemented by the larger SYSTEM DER ORGANISCHEN VERBINDUNGEN by Prager, Stern, and Ilberg.

The new edition of Huntress contains nine additional pages, the chief enlargement being in the section on the heterocyclic volumes and in the practice problems for locating compounds.

Now that the fourth edition of Beilstein and its first supplement are so near completion, some training in its use becomes almost essential to students of organic chemistry who expect to become chemists. Their best help, unless they read German fluently, will be Dr. Huntress' book.

AUSTIN M. PATTERSON

ANTIOCH COLLEGE
YELLOW SPRINGS, OHIO

MOLECULAR BEAMS. *R. G. J. Fraser*, Ph.D. Chemical Publishing Company of New York, Inc., New York City. 1938. ix + 70 pp. 25 figs. 10 × 16.5 cm. $1.25.

This short monograph aims to describe the more promising fields of the work being done with molecular beams. The first chapter is devoted to the experimental technic involved. The other subjects covered in the rest of the book are gas kinetics, magnetic moments, and electric moments. The diffraction of molecular beams at crystal surfaces and molecular scattering in gases are discussed, and space is devoted to the determination of molecular collision cross-sections as well as recent experiments on the gyromagnetic properties of atomic nuclei. The author has written a very interesting account of this important branch of research and has fulfilled his objective. The book can be highly recommended to advanced students in physics or chemistry and to teachers who wish to obtain a survey of some of the work in this difficult field.

ARTHUR A. VERNON

RHODE ISLAND STATE COLLEGE
KINGSTON, RHODE ISLAND

OUTLINES OF METHODS OF CHEMICAL ANALYSIS. *G. E. F. Lundell*, Ph.D., Chief Chemist, National Bureau of Standards, and *James Irvin Hoffman*, Ph.D., Chemist, National Bureau of Standards. John Wiley and Sons, Inc., New York City, 1938. xi + 250 pp. 115 tables. 15 × 23 cm. $3.00 net.

Probably the simplest step in a chemical analysis is the final determination of a particular element by means of a particular reagent. The capable analyst must know what elements are likely to be present in a given sample and how they can be separated, before he can finally determine each. The authors of this book outline in a systematic way the methods of chemical separations—the general strategy of chemical analysis, rather than the detailed tactics of final determinations to which most laboratory manuals and many texts are limited.

A few short chapters are devoted to the classification of materials and the elements each contains; sampling; and the preparation of solutions for analysis. The next seventy pages deal with methods of separating the elements, following in general the familiar scheme of qualitative analysis, with the additional discussion of groups precipitated by ammonium oxalate and by diammonium phosphate under different circumstances. This section closes with a discussion of the separation of the constituents of the groups and with special methods of precipitation. The third section of the book devotes twenty-five pages to outlining methods of determining the elements gravimetrically as oxide, sulfide, sulfate, phosphate, chloride, or silver salt, and also discusses the use of a half dozen of the newer organic reagents. The next fifty pages deal with volumetric methods, including acid-base, oxidation-reduction, iodometric and potentiometric titrations. Shorter sections are devoted to electrolysis and colorimetry. The last fifty pages are devoted to outlines of methods of analysis of a number of typical substances such as limestone, enamels, steel, brass, and bronze and with a discussion of the accuracy and precision of analytical results.

The authors summarized their aims as follows: "(1) To furnish analysts with information concerning the behavior of all the elements in the more important reactions that are used in analytical chemistry; (2) to stimulate searches for more selective reagents; (3) to enlighten chemists who hold chemical analysis in too light regard; and (4) to inform non-chemists concerning the complexities and difficulties that beset the analyst." They have succeeded in achieving these aims in a book written in a clear and forceful style and showing the stimulating effect of the authors' wide personal experience with chemical analysis in theory and practice. They make effective use of periodic charts in order to show the properties which elements have in common, whether it be colored ions, volatility or insolubility of sulfides in acid solutions. These charts summarize in a helpful way the differences and similarities upon which chemical separations are based.

The book could be read with profit by undergraduate students of analytical chemistry (and their teachers). It should be invaluable to those graduate students who want to develop a sound background for analytical work, and to practical analysts who are critically examining established methods of analysis, applying them to new materials or developing new procedures. The material is well indexed, and the outline contains a number of references to the original literature and to detailed books on quantitative analysis. The authors state that they omitted more extensive references and descriptions of procedure already contained in the APPLIED INORGANIC ANALYSIS of Hillebrand and Lundell. The present volume would be improved by the addition of specific page references to the older book, to which the reader could turn for details of the separations and determinations contained in the present stimulating outline.

FRANK T. GUCKER, JR.

NORTHWESTERN UNIVERSITY
EVANSTON, ILLINOIS

OUT OF THE TEST TUBE. *Harry N. Holmes*, Ph.D., Oberlin College. New edition, Revised and Expanded. Emerson Books Inc., New York City, 1937. x + 301 pp. 101 figs. 15 × 23 cm. $3.00.

David Dietz, science editor of the Scripps-Howard newspapers, has called Dr. Holmes's book "the best popular discussion of chemistry since the publication of Slosson's 'Creative Chemistry' some fifteen years ago."

First published in 1934, the new edition shows considerable enlargement and revision. The four new chapters have for their titles, "Atom Smashing," "Chemistry and the Motor Car," "The Chemist in Crime Detection," and "Winners of the Nobel Prize in Chemistry." In eight of the thirty-six chapters no additions or omissions have been made. Of the fifty-five new paragraphs over one half are to be found in six chapters dealing with recent developments in atomic structure and industrial chemistry. The sixteen paragraphs dropped from the first edition are found in seven chapters of the older work. There are twenty new figures in the revised edition. The size of the type has been reduced so that the number of pages has been decreased from 373 to 301. An index has been added.

JOHN R. SAMPEY

FURMAN UNIVERSITY
GREENVILLE, SOUTH CAROLINA

Heterogeneous Equilibrium

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TRADE ANNOUNCEMENTS

New Clarifier Announced by Graver

Every industrial engineer who has settling problems in connection with water, chemicals, solutions, or mixtures, will be interested in this brand new Seip Multi-tray Clarifier, which is designed and built on an entirely new principle, that of upward sludge filtration by means of periphery intake channel.

As compared with center intake channels, common to most settlers, the intake in the new Seip is ten times as large, which reduces proportionately the rate of speed of incoming liquids and results in minimum disturbance to the liquid.

The Seip Clarifier consists of one, two, or as many as seven (depending on the size of the tank and the capacity required) round, inverted trays, supported by brackets attached to inner side of tank shell.

The space within each tray forms a settling chamber, and, if the solution to be clarified is thick and has solids in suspension, these solids collect on the top of each tray (which acts as a bottom for the settling chamber above it) and function as an entangling medium for light-weight particles which would not otherwise quickly settle. This produces a clearer liquid.

Immediately above each tray there is a set of movable scrapers to carry away the surplus sludge. These scrapers are operated from a central shaft, the speed of which can be changed to suit specific gravity of sludge encountered and the depth of sludge desired.

The *Graver Tank & Manufacturing Co., Inc.*, with plants at East Chicago, Ind., and Catasauqua, Pa., is marketing this device.

Glass Marking Inks

Inks for marking on glass, porcelain, and metal have been developed by the *Westinghouse Electric & Manufacturing Company.*

Glass marking inks in both black and white, which adhere to a surface when applied with a steel pen are available. The composition of these inks is such that it will not interfere with the vacuum conditions in a vacuum chamber where it may be used. If set by the application of a moderate temperature they cannot be removed completely by ordinary scraping. Both of these inks can be used on glass beakers, porcelain surfaces, and thermometers, as well as for decorative effects.

A silver monogram ink, used primarily for the "W" monogram on Mazda lamps, has also been developed. This ink may be applied with a rubber stamp, but in order to fuse the metallic silver deposit into the glass, it must be dried by the application of heat.

A black monogram ink, drying in two minutes, and which can be applied with a rubber stamp is also on the market.

Clebar Watch Company Timers

The *Clebar Watch Co., 551 Fifth Avenue, New York City*, importers of Guinand and Gallet Timers, have added the Galco and Security Timers to their line of products in recent years. Their Timers are absolutely accurate because of the perfection of the parts, and because of the skill of the craftsmen who make them. *Clebar* Timers which are accurate to the hundredth part of a second are available. Models may be obtained to suit any requirements where a timer is needed.

Laboratory Instruments

"Laboratory Instruments, Chemical and Biological" is the title of Catalog 38 (98 pp., 21.5 × 28 cm.) of the *American Instrument Co., Inc., 8010–8020 Georgia Ave., Silver Spring, Md.*

New Glass Apparatus Catalogue

A 260-page catalogue of glass apparatus for the chemical laboratory has just been published by *Scientific Glass Apparatus Company, Bloomfield, New Jersey.* Two hundred pages are devoted to apparatus equipped with interchangeable ground glass joints, 20 pages to apparatus with the new patented metal clad joints, and 40 pages to microchemical glassware. Copies of the catalogue available on request.

Slip Test Block

Franklin Research Company of Philadelphia, manufacturers of Rubber Gloss Wax, announces the introduction of a compact and handy piece of testing equipment for measuring the frictional resistance of floor wax. This ingenious device permits the buyer to test the "Slip Hazard" of competitive floor wax in a practical and interesting manner right at his own desk.

This "Slip Test Block" is available to any commercial user of floor wax upon written request to the company at their general office at 5134 Lancaster Avenue, Philadelphia, Pennsylvania.

The Kisco Cool-Circle-Ator Table

This fan has made possible a new method of air recirculation and cooling. It is manufactured by the *Kisco Company, Inc., St. Louis, Missouri.* Through its special design and arrangement of blades, it draws an abundance of cool air and quietly recirculates it around the room without creating blasts, drafts, or annoyances.

The *Kisco* Cool-Circle-Ator Table is as handsome as it is efficient. It is effective because it recirculates the coolest air as no other fan can.

Its applications are fully illustrated and described in an attractively colored folder. It is designed and constructed by an established manufacturer with years of successful experience in building quality ventilating equipment, including the "Deflecto" Recirculator.

Verwiebe Models

The new Verwiebe Models of thermodynamic surfaces, manufactured by the *W. M. Welch Scientific Co., 1515 Sedgwick Street, Chicago*, are available for advanced students as well as for beginners. These models are, of course, dimensionally quite diagrammatic; the scale of some of the transitions had to be exaggerated arbitrarily to make the volume changes visible at all. Nevertheless, they are extremely useful in assisting the student to visualize the general behavior. The families of curves are easily traced on the models themselves and are readily explained.

"Grasselli Copper Compound A"

A new agricultural fungicide promising better control of certain fungous diseases of crops, greater safety to plants, and simplicity of application has been announced by *E. I. du Pont de Nemours & Company, Wilmington, Delaware.*

This new compound, temporarily called, "Grasselli Copper Compound A," is being made commercially available to growers following an extensive series of experiments and field tests by the makers and state agricultural experiment station investigators.

The new fungicide has been found effective in controlling fungous diseases of celery, cherries, cucumbers, tomatoes, beans, and ginseng. Recommendations for use on these plants are based on actual field tests, which also give evidence that the compound is safer to apply on copper-sensitive plants than is Bordeaux mixture. Tests are under way covering other crops, especially under conditions where Bordeaux causes injury.